ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. LII. No. 8 NEW YORK, SATURDAY, FEBRUARY 22, 1908. ISSUED WEEKLY

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TELEPHONE "21 Cortland." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

SUBSCRIPTIONS

One Year, United States $3.00
One Year, Canada 4.00
One Year, Foreign Countries 6.00
Single Copy, 10 cents. Back numbers, beyond one month, each . . .25

ADVERTISING

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

Published weekly by the ELECTRICAL REVIEW PUBLISHING COMPANY, 13 Park Row, New York. Charles W. Price, president and treasurer; Stephen H. Goddard, vice-president; H. S. Tuthill, secretary.

Entered at the Post Office at New York as second-class matter under the Act of March 3, 1879.

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ILLUMINATION AND DECORATION.

At a recent meeting of the New York section of the Illuminating Engineering Society, Mr. George Leland Hunter read a most instructive paper on "Light and Color in Decoration." An abstract of this paper and of the discussion which took place upon it will be found on other pages of this issue. It presents the decorator's side of the problem of illumination, and for this reason should be read by every student of the art of lighting. The neglect of the scientific principles of distributing light and the wasteful methods often unnecessarily employed were the chief excuses for the formation of this society, and for two years the engineer's views have been pretty thoroughly expounded. This naturally caused some dissent among the architects and fixture men, and they have been heard from. Now Mr. Hunter has given us the decorator's viewpoint, and makes out a very good case for him, and ably defends certain methods of illumination which have been criticized. The truth of the matter is that all sides are right in part, and it is only when one ignores the province of the others that he is apt to get into difficulty. The work may be divided in this way: it is for the architect to say what effect he desires in a room; the decorator will then say what the furnishings of that room should be in order that this effect may be produced, and what quality of illumination is needed to get the effect intended by the decorations. It is for the illuminating engineer to say how the quality of the light asked for may best be secured.

Mr. Hunter very properly says that all the light thrown against the walls and ceilings is not wasted. It is necessary that they should be lighted. Indeed, even when a room is intended merely for reading, it is most trying upon the eyes to have light only upon the book, the walls and ceilings being in darkness. On the other hand, when a room is intended for reading or other similar work, it is not sufficient to depend upon light diffused from a colored ceiling or wall, which may, to use Mr. Hunter's expression, "devour" nine-tenths, or more, of it. Such methods produce the most intensely illuminated surfaces where they are not wanted. The illumination of the book is less intense than the lighting of the ceiling, and even when the former is sufficient, according to well-established practice, the effect is not satisfactory. It is such methods as this that the illuminating engineer has been protesting against. If the reading room be lighted by a chandelier or wall-brackets which throw the light up instead of down, no matter where one sits there is a feeling of dissatisfaction and strain. In such

cases a little directed light from a reading lamp will often correct the trouble.

It is pleasing also to hear Mr. Hunter condemn the inconsiderate use of dark decorations. It is almost impossible to secure satisfactory illumination in a room finished in dark wood or with dark red or green paper. It is always gloomy and depressing, though it is probably for these very reasons that many think it artistic. Equally valuable were Mr. Hunter's suggestions regarding the use of colored shades. Too often the unthinking have the idea that the color of an object originates in it, and that when it is strong, a sharp contrast may be avoided by throwing light of a different color upon it. This, of course, is just the reverse of what should be done, as was so clearly stated by Mr. Hunter and shown by him in his experiments. The light originates at the lamp, and we see the colors of objects only because they absorb all the other colors of the light falling upon them. The green or the red of an object reaches the eye simply because these particular rays, starting from the lamp, are rejected, as it were, by the object, and hence thrown back to the eye; but if these rays be eliminated from the light, then the object will appear black because it will absorb all the remaining light which falls upon it. Hence contrasts are avoided by using a greenish light where the furnishings are green or a reddish light where they are red, and in the same way life is given to the room.

It is hard to overestimate the value of such papers as that presented by Mr. Hunter and the one read by Mr. Bassett Jones, Jr., last December, in which the latter explained the ideals of the architect. It is in such ways that the engineer and all having to do with the art of illumination can get a broad view of the subject and be enabled to work in harmony with others whose part is just as important if the final result is to be satisfactory.

THE ASYNCHRONOUS GENERATING STATION.

The paper presented by Mr. W. L. Waters before the American Institute of Electrical Engineers on Friday, February 14, again draws attention to that interesting machine, the induction generator. This, as all know, is no more than the asynchronous, or, as it is usually called, induction motor, driven above synchronous speed. Under these conditions the torque exerted between the moving and fixed parts is reversed and the machine becomes a generator, feeding back electrical energy into the system with which it is connected. When operated in this way it must be able to draw a magnetizing current from this supply system, since the machine is not self-exciting alone, and usually the frequency will be determined by other apparatus connected to the system; but the speed of the generator, the frequency and the output of the machine are so tied together that fixing any two determines the third.

Just why Mr. Waters selected the designation "non-synchronous generator" for this device he does not make clear. The usual term is that used above, induction generator, though this is not altogether good, since it easily leads to confusion with that entirely different machine, the inductor generator. But Mr. Waters's designation is itself not entirely free from objection.

The induction motor is in some ways one of the most interesting of electrical devices. Mechanically, its construction is almost ideal; the rotating part is perfectly symmetrical, may be easily balanced, and need carry no conductors requiring much insulation. On the other hand the stationary part, since the conductors are not subject to vibration, may be insulated for almost any potential. In fact, the machine may be made to combine the functions of a transformer with those of a motor.

Electrically, the induction motor is not less interesting. Its peculiar characteristics are best understood by comparing them with those of the direct-current shunt motor. In fact, they resemble the latter so closely that they can hardly be called peculiar. For example, as a motor, it is a constant-speed machine, as it adjusts itself to the applied load by only a slight change in speed. As the load is increased the speed decreases and the torque increases until a point of maximum is found, after which the torque begins to decrease, falling off to a low value at standstill. This behavior is identical with that of the shunt motor, which also shows a point of maximum torque if the armature reactions, as in the case of the induction motor, are large. Moreover, if an attempt be made to start a shunt motor by connecting it directly across the line, it will be found to develop little or no torque, because, under this condition, the field winding is short-circuited by the armature. If the load be removed from the motor and the latter be driven above its no-load speed, in each case the torque falls to zero; for the one machine, when the frequency of the induction motor is equal to that of the supply, and for the other, when the speed of the shunt motor develops a counter electromotive-force just equal to the applied. If the speed be still further increased, both machines begin to operate as generators and show all the characteristics of the shunt machine. An increase in speed in each case will cause that machine to pick up a greater part of the load of the system. This will go on until a point is reached at which the machine begins to drop its load, and we have the well-known shunt characteristic. A decrease of speed operates in the reverse sense, tending to transfer part of the load from the machine to the other generators connected to the system.

These characteristics of the induction motor are familiar to all, but the use of this machine in this way, while suggested several times, has only recently been tried seriously. This is the case described by Mr. Waters, and the type of equipment seems really to have been decided by other considerations. Here special requirements made it advisable to adopt a steam turbine rather than a reciprocating engine, but the high speed of the former made it undesirable to use a direct-current generator. The solution was to drive an induction motor as an induction generator, transforming the current from this machine into direct current by means of a rotary converter, the field excitation of the latter machine being adjusted so as to supply the necessary excitation of the induction generator. The performance of this arrangement is really somewhat remarkable, for

while at first it would seem that the use of two machines instead of one would seriously complicate matters and introduce increased losses, the actual efficiency of the system was really high, each device having a very high efficiency.

In such use of the induction generator the supply of the exciting current is simple, and is obtained by over-excitation of the synchronous converter; but when it is desired to use the induction generator for supplying alternating current, some means must be at hand for obtaining this exciting current, which is lagging with respect to the generator itself and leading when referred to the machine from which it is drawn.

As already mentioned, the simplicity of the design of the induction motor makes it an ideal machine for steam-turbine drive. However, it has advantages which are also useful when connected to a prime mover whose speed is not perfectly steady. Since the frequency of the system is not determined by the induction generator, slight variations in the speed of this machine will not set up cross-currents and cause hunting of the generating units. In fact, it should tend to steady the motion of its engine, because, as the speed increases, it picks up a greater part of the load, which it later drops as the speed again dies down. Non-uniformity of rotation then simply transfers the load from one generator to the other without causing the useless cross-currents which would flow between synchronous machines under the same conditions. A difficulty with the use of this generator in large stations is met in the necessity for supplying an exciting current, which must be leading with respect to the power consumers on the system. This current can not be furnished by induction motors, and hence, when there are such power consumers on the system, excitation must be provided for by other means. The capacity of the cables, when these are used for distributing the current, may be utilized, but since this capacity effect is not under control, it takes the control of the generator out of the hands of the station operator. A static condenser could be employed or an unloaded synchronous motor, or a synchronous machine could be installed to serve as an exciter. Mr. Waters proposes a combined equipment consisting of synchronous and non-synchronous generators, the former supplying the power when the induction motor load is heavy, and the latter being brought into use as the lighting load comes on. This idea suggests a combination of Mr. Waters's equipment with that proposed by Mr. Stott, whose idea was to combine gas engines and steam engines, the former being employed on account of their high thermal efficiency, and the latter to save the heat which would otherwise be carried off in the exhaust gases and cooling water. The steam-driven unit could be a synchronous machine, the gas-engine-driven unit a non-synchronous machine. The two should operate together without difficulty. With such an arrangement it would seem necessary to maintain a synchronous machine in operation throughout the day in order to provide the exciting current for the other. Since the steam unit would be operated by the heat losses of the gas engines, there is no objection to this arrangement.

It should be borne in mind that although the reversed induction motor is styled a non-synchronous generator, it is this in a limited sense only, because, as mentioned above, there is a definite relation between the negative slip of this machine and the load which it will carry. If the frequency of the system is fixed and the speed of the generator is fixed, the load which it will carry is also fixed; but this very relation will tend to assist in the regulation of the prime mover, which may be governed according to the load, and not for constant speed.

ELECTRIC WELDING.

The art of electric welding is comparatively old, so that it seems strange that it is not more frequently made use of in the shop. There are several systems of bringing metal to a sufficiently high temperature to weld it by means of electric currents, each of which has some advantages making it more or less suitable for certain conditions. Yet these are not utilized as often as they should be.

The general opinion seems to be that for electric welding an expensive apparatus is required, and that electrical energy is an expensive agent for producing heat. Neither of these objections to the system is of much weight, for although, for certain classes of work, a more or less elaborate device seems best suited for the character of the work, the regularity of the joint and the rapidity of working more than offset the expense of the machine. Moreover, there are some methods of welding which require nothing more than two water-tight barrels, a carbon rod and a source of electric energy. The expense of the equipment is practically nothing, unless it becomes necessary to install a special generator for supplying the welding current.

Regarding the cost of heat supplied in this way it should be remembered that, while the price is high when measured in kilowatt-hours, heat is being developed only while the metal is being heated; there is no appreciable loss; no attention is required to keep a furnace at a suitable temperature for welding and heating, and probably the actual cost of the energy used in making a weld would be little, if any, more than that of the heat furnished in a coal forge, if the latter be charged with all the loss taking place when the forge is not in use.

But the electric current may be used for welding and repair work where the ordinary type of forge is useless. Broken and defective castings may be repaired quickly and easily, and thus work which would otherwise be condemned be saved. And the intense localized heat which may be produced by the electric current may often be utilized in other ways for doing work which would otherwise require tedious handwork or expensive machining. In a shop provided with apparatus which makes available a current of several hundred amperes at fifty to a hundred volts, it will be found that this energy can often be used for saving much time or expense. An easily controlled method of producing intense local heating is a most valuable addition to the shop equipment. For this purpose the electric current is more flexible and more widely applicable than any other form of energy.

Testing of Steam-Electric Power Plants—I.

By Frank Koester.[1]

THIS treatise covers methods of conducting tests of complete steam-electric power plants. The plant under discussion is one designed by the writer and described in the ELECTRICAL REVIEW of April 20 and 27 and May 4, 1907. This plant has a normal total output of 3,000 kilowatts, and contains three 750-kilowatt horizontal turbo-generators. Space has been provided for a fourth unit of equal or greater capacity.

The steam is supplied by six 275-horse-power horizontal water-tube boilers, space being left for two additional units to be installed coincidentally with the fourth turbine set. Coal is brought to the side of the building in cars, and is elevated by a bucket conveyer into overhead bunkers. While there is a method of weighing the coal in cars by means of a track scale, there is no accurate way of weighing the coal from each individual bunker to the grates. The coal must therefore be weighed in barrows for testing purpose, which is the most accurate means of obtaining the amount burned.

For boiler-feed purposes city water is used, and as the plant is operated condensing the water may be used over and over again. The only make-up water required is that which is lost due to leakage. Should the city water fail the make-up water can be supplied by house pumps which are connected to the circulating water intakes.

The boiler-feed pumps, which are of the outside-packed plunger type, are located in the boiler room beneath a platform upon which is located a feed-water heater, of the closed type, and the make-up tank.

The hot-well pumps deliver the water of condensation from the hot-wells to the make-up tank. From this tank the water flows by gravity to the boiler-feed pumps, which in turn pump it through the closed heater into the boilers.

The boilers are provided with mechanical stokers and superheaters. The latter may be cut out in case of emergency and the boilers still be kept in commission. The piping is so arranged that either saturated or superheated steam may be used.

Each turbine is provided with a surface condenser of 3,000 square feet. They are located directly beneath the turbines in the basement of the generating room. An atmospheric relief valve is provided for each turbine so that it may run non-condensing.

The circulating-water pump is of the centrifugal type, direct-connected to a horizontal high-speed engine. The vacuum pump is of the single-horizontal type. The water of condensation is removed by the single pump, controlled by an automatic valve operated by the water line of the hot-well, and pumped to the make-up tank located in the boiler room. All these pumps are grouped around each individual condenser and are also located in the basement.

The generators are direct-connected to the turbines and run at 1,800 revolutions per minute, generating three-phase, sixty-cycle current at 2,300 volts.

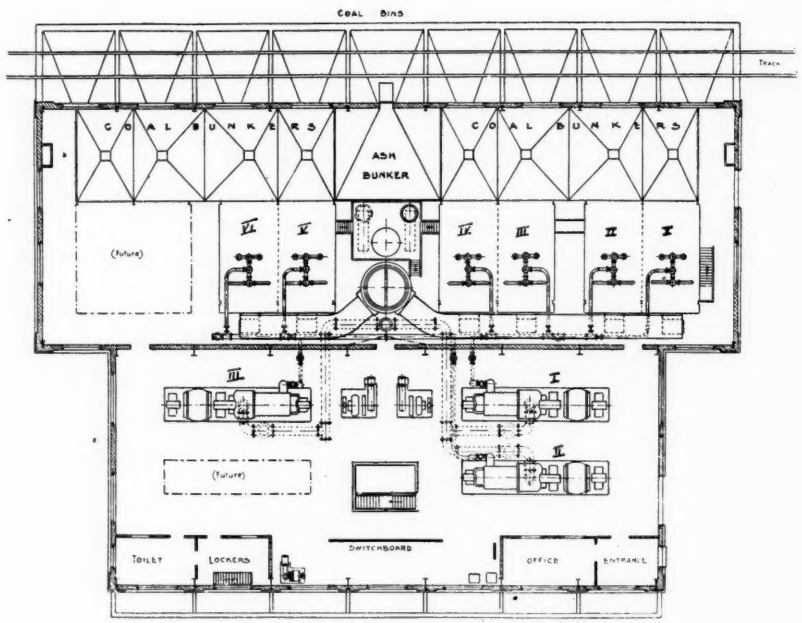


FIG. 1.—PLAN SHOWING GENERAL ARRANGEMENT OF EQUIPMENT.

There are two thirty-kilowatt exciters operated by high-speed horizontal engines. These are duplicate sets, one being kept in reserve.

In order to give a general idea of the equipment to be tested in this plant, Fig. 1 is submitted. The units to be tested are turbine No. I and boilers Nos. III and IV, and their corresponding auxiliary machinery.

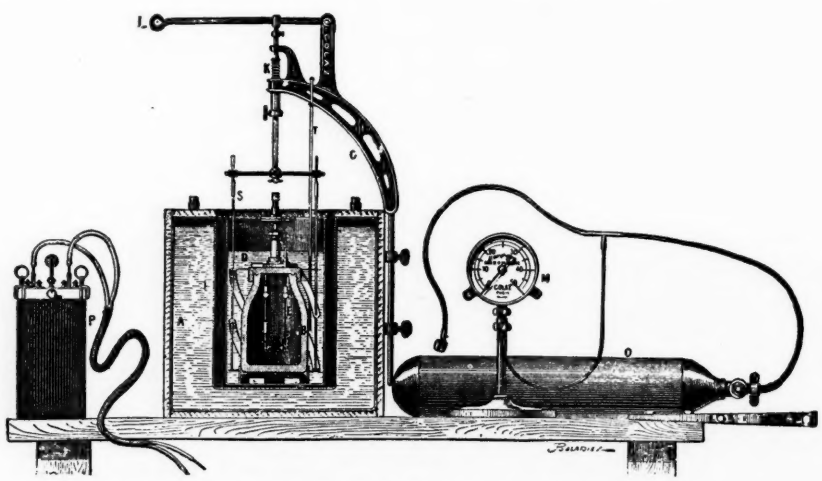


FIG. 2.—MAHLER'S FUEL CALORIMETER.

[1] Consulting Engineer, New York, author of "Steam Electric Power Plants."

The figures given in the tesis, which are here described, are based on the equipment of the above-mentioned plant. The methods adopted may, however, be used for any similar station. In this particular case one unit only was tested with its respective boilers and auxiliaries, as all other units were duplicate sets.

During the time that the test was run the plant had to give an output of 1,500 kilowatts, furnished by two turbo-units and four boilers. In order to separate

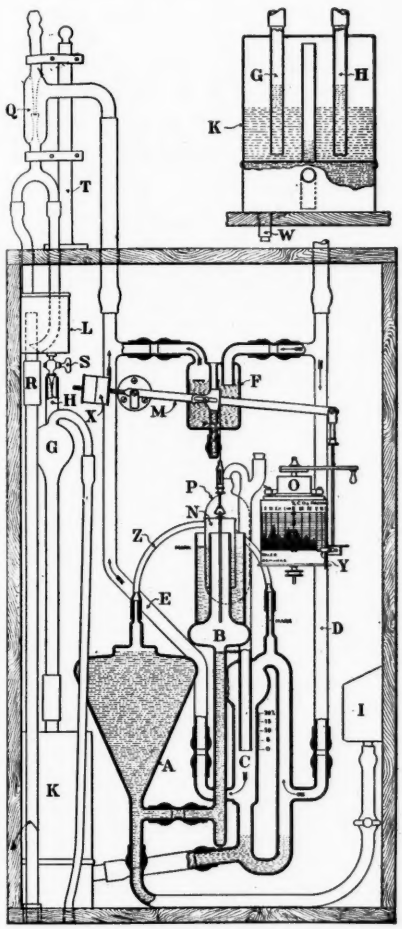


FIG. 3.—"SARCO" CO_2 RECORDER.

the units to be tested from the remainder of the plant they were isolated by the necessary valves. Turbine No. II remained idle, as well as boilers Nos. I and II. Boilers Nos. V and VI supplied steam to turbine No. III. As will be seen later (under the heading "Testing Auxiliaries") all exhaust from the auxiliaries, of turbine No. I exhaust into the condenser of turbine No. II. In order to condense this exhaust steam the circulating-water pump and hot-well pump of turbine No. II were run; the vacuum pump was not run, as there was no vacuum required in the condenser.

ANALYSIS OF COAL.

There are different methods of determining the heat value of coal. A theoretical method is by the use of the well-known Dulong formula:

B. t. u. $= 145\ (C + 4.28)\ (H - \frac{O}{8} + O \times .28\ S)$, in which

C = Carbon.
H = Hydrogen.
O = Oxygen.
S = Sulphur.

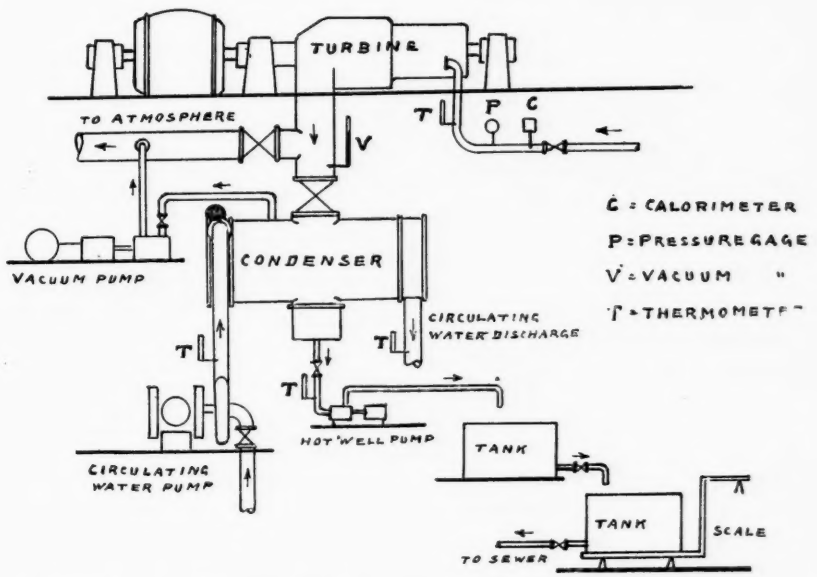


FIG. 4.—DIAGRAM OF TURBINE AND CONDENSER PLANT, SHOWING PIPE CONNECTIONS, TESTING TUBES, ARRANGEMENT AND POSITION OF MEASURING INSTRUMENT.

As this formula is theoretical the number of British thermal units may vary five per cent to ten per cent of the actual heat value of the coal.

A more accurate and convenient way is by testing the coal with a calorimeter, which was the method adopted. Fig. 2 shows the apparatus used; it is of the Mahler type. Samples for testing purposes were obtained at intervals and sealed in hermetical tin boxes. Upon testing in the calorimeter the coal was found to contain 13.410 British thermal units. In order to determine the chemical composition of the coal samples were submitted to a laboratory and the following results obtained:

Fixed carbon	53.10	per cent
Volatile matter	36 60	"
Moisture	1.35	"
Sulphur	1.90	"
Ashes	7.05	"

BOILER TEST.

The boilers were tested both for capacity and efficiency. Previous to the test the boilers were thoroughly examined, cleaned and heated up.

Upon starting the test the thickness of the fire and pressure and temperature of steam were noted and the position of water in the gauge glass marked. The test was run for a period of eight hours, four hours in the morning and four hours in the afternoon. Readings were taken every forty minutes. The coal was weighed in barrows on a beam scale. The ashes were collected in the thoroughly cleaned ash pits and stored in cans and weighed at the completion of the test.

As at the test several boilers of the plant were in operation, one of the boiler-feed pumps was disconnected and separately piped to the two boilers which were being tested. The water was drawn from the make-up tank in which it was measured. The feed-water temperature was taken close to the boilers by means of a recording thermometer. In addition a mercury thermometer was used, which was read at the regular intervals. The temperature of the feed-water was also taken before entering the feed-water heater. In some cases a water meter is placed in the feed line as a check on the measuring tanks, while in other instances the tanks are entirely dispensed with, two water meters being substituted, one as a check on the other. However, in this case these precautions were not deemed necessary.

As previously stated the thickness and quality of the fire were noted at the time of starting the test and at the conclusion a fire of similar thickness and quality was on the grates. The flue and chimney temperatures were obtained by the use of pyrometers, the intensity of the chimney draft was measured by an ordinary water-

draft gauge. These figures were not only taken at the chimney, but also in the flue and in the final passage in the boiler, in order to detect leakages in the flue and boiler setting.

For the purpose of measuring the carbon dioxide in the waste gases a CO_2 recorder was installed. A similar apparatus to the one used is shown in Fig 3. This apparatus records at regular intervals on a timed chart.

As automatic damper regulators are installed, a uniform pressure was constantly maintained in the main steam line. The steam pressure and temperature were taken close to the boiler, as well as at the turbine. Calorimeter readings were taken at the boilers and at the turbine in order to ascertain the percentage of moisture in the steam, as tests were made with both saturated and superheated steam.

So as to prove the capacity of the boilers an overload test was run. This test was run merely to ascertain the percentage of overload that the boiler would withstand.

During this overload test one boiler only was operated and evaporated 13,278 pounds of water per hour. This is equivalent to 426 horse-power or fifty-five per cent overload.

The following tables gives the principal results obtained from tests on each boiler, the turbines having been run under ordinary operating conditions, which means a fluctuation of from three-fourths load to one and one-half load on the generator. The figures given are averages.

RESULTS OF BOILER TESTS.

Water-heating surface (square feet)	2,750
Superheated surface (square feet)	500
Grate surface (square feet)	60
Steam pressure in pounds (gauge)	180
Temperature of superheat (degrees)	110
Chimney draft (inches water)	0.75
Barometer (inches mercury)	29.5
Heat value of coal, B. t. u.	13,410
Total weight of water evaporated (pounds)	7,095
Water evaporated per pound of coal (pounds)	9
Coal burned per square foot of heating surface (pounds)	0.28
Coal burned per square foot of grate surface (pounds)	13.1
Efficiency of boiler per pound of coal (per cent)	75.3

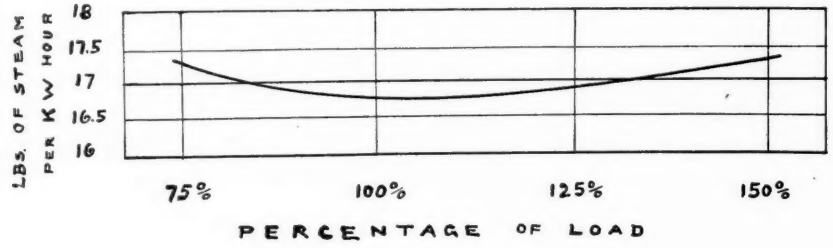


FIG. 5.—STEAM CONSUMPTION OF 750-KILOWATT TURBINE.

TURBINE TESTS.

The turbine is tested for steam consumption and capacity. In order to ascertain the steam consumption the water of condensation is collected and measured. This was done as follows:

Fig. 4 shows a diagram of the turbine, condenser and their auxiliary machinery arranged for testing purposes. The steam before entering the turbine is examined as to quality, temperature and pressure. To ascertain the quality of the steam a calorimeter was used, readings were taken at regular intervals simultaneously with those of the boiler. At the same time the pressure and temperature were noted.

The exhaust steam was discharged into the condenser and the water of condensation removed by means of the hot-well pump, being stored in a receiving tank. From this receiving tank the water flowed by gravity into a weighing tank located on a beam scale. The weighing was done in the usual manner, *viz.*, when the weighing tank filled the water was cut off from the receiving tank. The weight of water was then noted. The drain from the weighing tank was then opened, allowing the water of condensation to waste to the sewer.

The vacuum was noted in the exhaust pipe to the condenser by means of a mercury column. In conjunction with this recording barometric readings were taken in order to ascertain the atmospheric pressure so as to know the actual vacuum. The temperature of the water of condensation was also taken, as well as the temperature of the circulating water supply and discharge.

The tanks for receiving and weighing the water of condensation for this particular instance were ordinary barrels. In many large plants where tests for steam consumption are frequently made, a condition that should obtain in all stations, permanent means for conducting this test are devised. In these cases wrought-iron measuring and weighing tanks are provided. In some cases automatic weighing tanks are installed. Fig. 5 shows the steam consumption for three-quarters load, full load and one-quarter and one-half overload.

(To be concluded.)

RESULTS OF TURBINE TESTS.

	75%	Full load	125%	150%
Percentage of load				
Steam pressure, pounds	174.5	176	177.6	174.2
Temperature at throttle (total), degrees	457.3	453	435	432
Quality of steam	Dry	Dry	Dry	Dry
Vacuum, inches mercury	27.9	27.7	27.7	27.6
Barometer, inches mercury	29.5	29.5	29.5	29.6
Vacuum corrected to 30 degrees	....	....	....	....
Barometer	28.4	28.2	28.2	28
Revolutions per minute	1,820	1,810	1,803	1,797
Output in kilowatts	566	752	940	1,123
Total steam consumption, pounds	9,791	12,634	15,914	19,428
Steam consumption per kilowatt-hour, pounds	17.3	16.8	16.93	17.3

To Guard Wireless Messages.

On February 13 President Roosevelt transmitted to Congress a letter from the Secretary of the Navy, recommending the enactment of laws making it a punishable offense "to originate or transmit a false wireless message purporting to be official, or to break in and interfere with any wireless station while it is transmitting an official message, or to refuse to cease or fail to cease sending a private wireless message when called upon to do so by an operator having an official message to be sent." The restrictions suggested are intended to apply particularly in times of peace. In times of war more rigorous restrictions would be indicated.

May Dissolve Telephone Company.

An order was signed on February 11 by Vice-Chancellor Howell, at Newark, N. J., directing the United States Independent Telephone Company to show cause why it should not be adjudged insolvent and a receiver appointed. Application for the order was made by John R. Hardin, of Pitney, Hardin & Skinner, as counsel for James M. E. O'Grady, of Rochester, N. Y., a creditor and stockholder of the company.

American Institute of Electrical Engineers.

The 225th meeting of the American Institute of Electrical Engineers was held in the Engineering Societies Building, New York city, on Friday evening, February 14. The meeting was called to order by President Stott at 8 o'clock, and the secretary announced that 154 associate members had been elected at a meeting of the board of directors held in the afternoon.

The first paper was read by W. L. Waters, entitled "The Non-Synchronous Generator in Central Station and Other Work." This paper is published, in slightly condensed form, on other pages of this issue.

Charles W. Stone presented a paper entitled "Some Developments in Synchronous Converters." In this attention was called to the large use of these machines in connection with railway and lighting systems, although their use dates back only about ten years. Recent practice has shown that sixty-cycle converters may be made reliable, although the prevailing type is for twenty-five-cycle. A general tendency in the design has been toward higher speeds with a view to reducing space occupied, first cost and weight. One notable advance has been the design of vertical converters. In these the vertical shaft is stationary, the armature alone revolving. The weight of this is taken up by a bearing through which oil is forced under pressure, while a guiding sleeve, practically as long as the armature, holds the latter in its central position. This type of design has a good many advantages; one of these being the ease with which all the brushes are inspected and adjusted. As there is no end play, uniform wearing of the commutator must be provided for. This is done by staggering the brushes. Lubrication of the commutator is secured by the use of a number of graphite brushes. Mr. Stone then described briefly some of the newer methods of regulating the voltage of converters. One of these, due to J. E. Woodbridge, takes advantage of the fact that the ratio of conversion from alternating to direct current depends upon the magnetic distribution under the pole-face. By splitting the poles up into three sections and placing separate windings upon them, these being divided into two sets, control over the distribution is obtained. One of these sets of windings furnishes the normal excitation, while the other set varies the relative magnetization of the three sections of pole-face. Another scheme, due to J. L. Burnham, is somewhat similar, though simpler. In this the pole is cut into two sections. On one is placed the normal exciting coil, and on the other a coil used for varying the magnetic distribution. Anti-hunting devices were referred to briefly, it being thought that the most satisfactory is that in which copper rods are passed through the face of the pole tips and connected together by heavy copper rings.

J. E. Woodbridge read a paper entitled "Some Features of Railway Converter Design and Operation." In this Mr. Woodbridge also calls attention to the large increase in the use of converters which has taken place, there being about 1,000,000 kilowatts, aggregate rating, of the machines now in use. The author then took up the different methods of tapping converters, comparing the three-ring with the six-ring method. The six-ring arrangement is more efficient, besides giving a more uniform heating of the armature copper. The author discussed the starting of synchronous converters from the alternating-current side, showing that this may be arranged so as not to disturb the system too seriously and not to overload the converter. Converters may be started in this way repeatedly, as quickly as they will slow down after being brought up to speed. In fact such machines are better self-starters than constant-speed induction motors of high efficiency. Mr. Woodbridge then discussed the compounding of converters, describing the use of series reactances. Overcompounding has gone out of fashion on account of the low power-factor which it causes. In order to reduce the average heating, compound converters should have their shunt fields adjusted so as to draw a considerable lagging current at no load. The best results are obtained with systems in which the resistance approximates ten per cent, by increasing the natural reactance of the circuits approximately to twenty-five per cent, and the use of a series field of such strength as to balance about one-half full-load armature ampere turns, with transformer ratios such as to give normal direct voltage with at least one-fourth full-load current lagging at no load. In two appendices to this paper Mr. Woodbridge gave a mathematical analysis of the heating loss in a six-phase winding and the regulating reactance.

President Stott announced that a special meeting would be held on March 5, at which the subject of forest preservation would be considered.

F. G. Clark, electrical engineer of the Pennsylvania Tunnel and Terminal Railroad, was called upon to open the discussion. Mr. Clark took up in detail the advantages which Mr. Waters had considered were possessed by the non-synchronous generator. As an operating engineer he was rather of the opinion that the author, in his enthusiasm over advantages, some of which must be admitted as important, had failed to realize the weight of certain disadvantages which preclude the use of the non-synchronous generator in large power stations where synchronous generators are now installed. The claim that the excitation of a non-synchronous generator can be controlled from a distant substation did not appeal to him as practicable. There are a few possible happenings between a substation and a power station which would cause either voltage rises or interruptions chargeable to such operation. He believed it safe to say that the synchronous converter, with its direct-current, engine-driven starting generator, must be located at the power station. He believed Mr. Waters' point, that when the non-synchronous generator is used with synchronous converters it is superior to engine-driven, direct-current converters, was well taken. Turbine-driven, direct-current generators have not proved very satisfactory, and it is doubtful if they will ever be used to any great extent. The slow-speed engine sets are efficient for one point of load, and uneconomical when the load varies through wide ranges. The non-synchronous generator and synchronous converter combination may show sufficient economy to displace engine-driven generators in some stations, and should generally be able to merit adoption when additional power is required.

Paul M. Lincoln, of the Westinghouse Electric and Manufacturing Company, presented a communication from C. F. Scott, which generally commended the proposition presented by Mr. Waters. Mr. Lincoln then proceeded to present an analysis of the split-pole rotary proposed by Mr. Stone and Mr. Woodbridge. By means of lantern slides which were thrown on the screen Mr. Lincoln showed that this analysis indicated that the split-pole machine would produce deviations from the true sine wave-form, which, he considered, would make the machine, in some cases, uncommercial.

Dr. Charles P. Steinmetz stated that he did not care to discuss Mr. Stone's paper, because when this type of split-phase converter was first brought to his attention he was not very favorably impressed with

it. He rather expected that this machine would give wave-shape distortions, poor power-factor and poor commutation. When the machine was built and tested he was somewhat surprised that the wave-shape distortion did not materialize. The power-factor was high, and the commutation good. When the machine had passed through various sizes and was put into commercial service his only consolation was that prominent and well-informed engineers had arrived at the same conclusion as he had theoretically. His final conclusion was that even nowadays it is wise to check up theoretical reasoning by experimental test, because these two do not always agree; not that the theoretical reasoning is wrong, but because, in the premises upon which the theoretical reasoning is based, some elements which are essential may not have been given the proper weight.

He was very much pleased with Mr. Waters' paper, and was grateful for the very strong argument he made in favor of this type of generator. He had always believed that, in some instances, it was a very desirable type, and he hoped to see it introduced, perhaps not so universally as Mr. Waters believed, but to a considerable extent. He took exception to the designation which Mr. Waters had given this type of apparatus, and did not approve of the plan to introduce a new name for a known apparatus. In this particular case it appeared to him that the name "induction generator" is analogous to the name "induction motor," implies the excitation of the machine by induction, and that the name "non-synchronous machine" is rather a misnomer. There is one field to which he believed the induction generator is pre-eminently suited—that is, for the parallel operation of water powers with steam power. In those numerous cases where a water power of limited size is available, and the balance of the power beyond that given by the water-wheels is supplied by a steam plant, the problem is to take all the load from the water power which can be given and supply only the deficiency by the steam power. In this case the synchronous machine controlled by a steam engine operating at constant speed would be desirable, while the induction generator direct-connected to the water-wheel would operate without a governor on the water-wheel. In that case the induction generator speeds up above synchronism until it consumes all the power given by the water, little or much, depending upon the season of the year and conditions. It takes all the power which the water can give and supplies it to the system, and the steam engine supplies the rest.

Dr. Steinmetz said that we have just touched the supply of power available from the water powers of the country. While some of the largest powers where energy is available in the most concentrated form are being developed, there is an enormous amount of power in the country in small creeks and rivers which is going to waste. There will come a time when the large water powers are all taken up, and we will have to approach the problem of gathering all these small streams and rivers. Here only the induction generator can solve the problem. The way to solve the problem of these small powers is to build a small stone dam across the creek, just enough to get a head to feed into a pipe of a few hundred feet, with the water running against some cheap form of hydraulic turbine. The induction generator would be directly connected to the turbine and to the low-tension side of a step-up transformer, while the high-tension side of the high-tension transformer would be joined into a line leading along the creek. A number of such stations, which could be very simple and cost very little, could be strung along the creeks and rivers, all feeding into the same transmission line. The power from these dozens or hundreds of small induction-generator plants could be gathered in one central collection station by synchronous motors with automatic feed control, and power supplied to those points where it was required.

The papers were also discussed by Dr. C. A. Adams, J. R. Bibbins, Philip Torchio and J. B. Taylor, and the discussion was closed by the authors.

The meeting was then adjourned.

Annual Report of the Mackay Companies.

The annual report of the Mackay Companies, controlling cable, telephone and telegraph companies in the United States, Canada and Europe, was issued on Saturday, February 15. The balance sheet as of February 1 shows the value of investments in other companies to be $92,075,503. The receipts of the Mackay Companies for the year ended February 1 were $3,830,390, which compares with $3,310,328 for the previous year.

The report states that during the year 1907 the earnings of the Commercial Cable Company, which has paid regular quarterly dividends for over eighteen years, showed substantial gains in gross receipts and net profits. On account of the telegraphers' strike the net profits of the land-line system were not equal to those of 1906, but were larger than those of 1905.

At the annual shareholders' meeting, held February 15, 1907, the number of trustees was increased from five to seven, and the two additional trustees elected were Robert A. Smith, of the banking house of Osler & Hammond, Toronto, and Pliny Fisk, of the banking house of Harvey Fisk & Sons, New York.

The Mackay Companies has no debts.

During the year 1907 the trustees caused to be laid from New York city direct to Havana, Cuba, a submarine cable, to be operated in connection with the Commercial Cable Company, and opened it for business on October 21, 1907, giving a one-minute service. The earnings from the operation of this cable are satisfactory. Its entire cost has been paid out of the current profits of the system.

The physical properties of the subordinate companies are maintained in excellent condition. All reconstruction is charged to operating expense.

The recent completion of certain underground construction in England has enabled the Commercial Cable Company to dispense with aerial wires from Bristol to London. That company's submarine and underground cables between New York and London are now free from all the dangers of disturbance incident to overhead construction.

In the report special attention is given to the relations existing between the Mackay Companies and the American Telephone and Telegraph Company. In connection with this the report is quoted as follows:

"The trustees have confidence in the stability and future of the telephone company and realize that the natural relations between the telegraph and telephone will lead inevitably to closer relations between these two companies because of the great economies that are possible, especially in the way of avoiding duplication of pole lines, rights of way, office rents, managers, cost of maintenance, etc., throughout the vast expanse of territory of the United States. The management of the American Telephone and Telegraph Company has made radical changes during the last year. Retrenchment has taken place in every branch of its business. Expenses have been cut down, the staff reduced and extensions not urgently required have been deferred until the stock and bond market admits of easier money at lower rates. The trustees of the Mackay Companies are in entire accord with the policy of Mr. Vail, the president, and the administration of the telephone company."

The following are the officers and trustees of the Mackay Companies: Clarence H. Mackay, president; George G. Ward, vice-president; Edward C. Platt, treasurer; Albert Beck, secretary; trustees—Clarence H. Mackay, William W. Cook, George G. Ward, Dumont Clarke, Edward C. Platt, Pliny Fisk and Robert A. Smith.

THE NON-SYNCHRONOUS GENERATOR IN CENTRAL STATION AND OTHER WORK.[1]

BY W. L. WATERS.

That an induction motor could act as a generator and return power to the line when driven at a speed above that of synchronism has been known for many years. It has, however, always been regarded as more or less of a scientific curiosity, and except in the case of the Swiss three-phase mountain roads, where the motors are sometimes allowed to run as generators to brake the train on descending heavy grades, the non-synchronous generator has had but few commercial applications. The fact that the characteristics of this generator are such that it must receive a lagging current from the system, the magnitude of which is for a given machine definitely decided by the slip of the generator above synchronism, combined with the fact that when connected to a circuit it has no definite voltage and frequency of its own, make it lack the flexibility of the synchronous generator. In 1895 B. G. Lamme proposed running a non-synchronous generator with an unloaded synchronous motor, the generator to supply the watt component and the motor the wattless component of the current in the system. But though this suggestion rendered the non-synchronous generator a practical machine, it is easily understood that on account of the lesser flexibilities when compared with the synchronous generator, it has not appealed to the central station engineer as a desirable addition to his equipment.

The question as to the advisability of adopting the non-synchronous generator for power station work was decided adversely by engineers at the time when steam engines and water turbines were the only practical prime movers. But to-day we have to deal with steam turbines and gas engines, and the coming of these two new types of prime movers has altogether changed the situation in regard to the use of this generator for power station work. It often happens in such cases that the real meaning and possibilities of the introduction of types of machinery with such fundamentally new characteristics as the steam turbine and gas engine are not recognized until they are accidentally forced upon us. This has been the case in the present instance; the question of the use of non-synchronous generator with steam turbines was not seriously considered until it was brought up indirectly. In 1904 a copper smelting and rolling company was installing a 1,200-kilowatt, 200-volt, direct-current generator for electrolytic work. It was desirable to continue the good steam economy on variable loads, the small floor space and reduced maintenance of the steam turbine, and at the same time to generate 200-volt direct current. A 1,200-kilowatt, 6,000-ampere, 200-volt, 1,800-revolutions-per-minute, direct-current generator was not considered practical, and a non-synchronous generator, together with a synchronous converter, was suggested as an alternative. It was finally decided to adopt this type of equipment, and a 1,200-kilowatt, six-phase, 140-volt, thirty-cycle, 1,800-revolutions-per-minute generator, together with a 1,200-kilowatt, six-phase, 150-revolutions-per-minute converter, was installed to supply the required 6,000-ampere direct current at 200 volts. A direct-current exciter for the converter was provided, so that the voltage of the converter's direct current could be varied from 100 to 230 volts without any danger of instability. The exciter is compound-wound to give constant voltage on the direct-current side of the converter, and the power-factor gradually rises from about twenty-five per cent at no load to about ninety-six per cent at full load. When starting up the set, the converter is run up to speed from an auxiliary source of direct current, and the generator by its turbine. They are then thrown together, the generator driving the converter as a synchronous motor, and the converter supplying the magnetizing current of the generator. The governor of the turbine decides the frequency of the set, and the slip of the converter behind the generator is proportional to the load, being about one per cent at full load. This equipment has been running now for about three years and operates perfectly. The generator is similar in arrangement to the old open-type turbo-generator, and in consequence is rather noisy, but with the modern enclosed type of generator it is possible to arrange the air circulation better, and to obtain as a result a much quieter running machine.

This installation is given in detail, as it is one instance where the adoption of this apparently inflexible type of generator resulted in an installation, which combines the flexibility of the standard direct or alternating-current generator with the capacity for heavy overloads of the synchronous converter, and the reliability and robustness of construction of the non-synchronous generator. No other electrical equipment which could have been installed would have given the good results that were obtained. And though the existing conditions rather forced the choice of the equipment in this case, the results so thoroughly met expectations that engineers began to consider whether the development of the last few years in regard to prime movers had not changed the non-synchronous generator from a scientific curiosity to a generator possessing great advantages for certain conditions of power station work.

GENERAL CHARACTERISTICS OF THE NON-SYNCHRONOUS GENERATOR.

As most engineers are more familiar with the characteristics and performances of the induction motor than they are with those of the commercial non-synchronous generator, it will be well to show how the characteristics of the two machines are allied. An induction motor of given characteristics carrying a certain definite load runs at a fixed speed relatively to that of synchronism, and it takes a current the magnitude and phase of which are definite. The torque exerted by the motor is proportional to the product of the current induced in the short-circuited secondary and the magnetic flux. The electromotive force and the current induced in the secondary, and hence the torque, are proportional to the rate at which the secondary conductors cut the primary magnetic field, that is, to the slip of the rotor above or below the speed of synchronism. As the speed of the motor gradually rises to that of synchronism, the current in the secondary and the torque gradually fall, till at the speed of synchronism they both become zero. If the speed of the machine still continues to increase, the secondary conductors cut the primary flux in the reverse direction, and the induced electromotive force, the secondary current and the torque become negative; that is, the machine requires a mechanical power to drive it above the speed of synchronism. The machine now returns electrical power to the circuit and has become a generator. When running as a motor, the current is never in phase with the impressed voltage, for two reasons: (1) the motor requires a certain wattless magnetizing current, and (2) the motor windings, both primary and secondary, have a certain amount of self-induction. This makes the current lag behind the impressed voltage by an angle, depending on the characteristics of the machine and on the load it is carry-

[1] A paper read before the American Institute of Electrical Engineers, New York, February 14, 1908. Slightly condensed.

ing. When the machine runs above synchronism as a generator, it still takes from the circuit the wattless magnetizing current, and the circuits still possess their self-induction. And as the watt component has reversed in direction, this will mean that the primary current lags less than 180 degrees behind the voltage impressed by the circuit on the generator, hence the current leads the electromotive force supplied by the generator to the circuit. Thus we have as a fundamental characteristic of the non-synchronous generator, that for a given load it runs at a certain definite speed above that of synchronism, and that (a) it supplies a watt current which represents the power delivered by the generator to the circuit, and (b) it takes a wattless magnetizing current from the system, the magnitude of which depends on the voltage and on the watt component of the current. Hence this type of generator can not supply a lagging current to the outside circuit and can only deliver power to a circuit which can provide the lagging magnetizing current required by a non-synchronous generator; for any given speed the magnitude and phase of the current which the generator will supply are definitely fixed. Also, as the wattless component of the current varies in magnitude when the load of the machine changes, we must have in circuit some apparatus which can supply a variable amount of lagging current, and which will keep the voltage of the circuit constant. It is these apparently rigid and inflexible conditions which have prevented any extensive use of the non-synchronous generator, and it is only because under certain modern conditions these limitations do not mean serious disadvantages that this generator is now put forward as an important part of a power station equipment.

Usually the load on a power station is either non-inductive or has a lagging power-factor, so that if this type of generator is used, the lagging current required by the generator, and perhaps also by the outside circuit, must be artificially supplied. There are two ways of obtaining the lagging current required by the non-synchronous generator: (1) from a condenser; (2) from a synchronous generator or an over-excited synchronous motor. It would not be desirable commercially to install a condenser specially to supply the required lagging current, as the cost would be prohibitive, but a large cable system has quite a considerable electrostatic capacity, and the lagging current supplied by this system will usually help greatly in reducing the size of the necessary synchronous machine. In any case, however, it is necessary to have a synchronous machine, either a motor or a generator, in the circuit in order to set the frequency and the voltage. If we have the non-synchronous generator running together with a synchronous generator, the latter machine supplies all the lagging wattless current required by the non-synchronous generator and the outside circuit, while the voltage of the circuit is decided by the excitation of the synchronous generator. The distribution of the watt component of the current between the two machines is decided by the governors of the prime movers. The load which the non-synchronous generator takes depends on the percentage slip by which it leads the synchronous generator, and the remainder of the load is taken by the synchronous generator. When additional load comes on the station it first comes on the synchronous generator, and then, as this machine slows down and allows the slip of the non-synchronous generator to increase, part of the load is transferred to this latter machine. In any case, the voltage regulation of the system is that of the synchronous generator, and the voltage of the circuit under any condition of load is decided by the excitation of this machine. If we have the non-synchronous generator running together with a synchronous motor or synchronous converter, then the same remarks apply. The voltage regulation is that of the synchronous machine, and the voltage of the circuit is decided by the magnitude of its excitation. When the load increases, the additional load comes first on the synchronous machine, energy being supplied to the system from the momentum of its rotating part, and then as the machine slows down a little, the load is transferred to the non-synchronous generator, the synchronous machine supplying simply the additional lagging current required by the generator when carrying the additional load. The synchronous machine supplies at all times all of the lagging wattless current in the circuit, and the governor of the prime mover driving the non-synchronous generator, decides the frequency of the circuit, the synchronous machine slipping behind the generator an amount just sufficient to allow this latter machine to supply all the power required by the circuit.

NON-SYNCHRONOUS GENERATORS IN POWER STATION WORK.

Obviously, the disadvantage of the non-synchronous generator for power station work is that it can not carry a lagging wattless current; that it requires an additional lagging wattless current to excite it. The power-factor of the current supplied by such a generator is a direct measure of the amount of wattless current required to excite it under that particular load. The power-factor which can be obtained in designing any non-synchronous generator depends on the size, speed, voltage and frequency of the machine. Low speed, high voltage and high frequency all tend to lower the power-factor which can be obtained.

Table I gives the characteristics of steam-turbine and gas-engine-driven non-synchronous generators of from 1,000 kilowatts to 10,000 kilowatts for 2,200 and 13,200 volts, and for twenty-five and sixty cycles. The table shows that on high-speed 2,200-volt generators the power-factor rises as high as 98.25 per cent, and that we can obtain on such machines a power-factor which averages ninety-seven per cent to ninety-eight per cent from one-half to one and one-quarter load, while the no-load magnetizing current is less than ten per cent of the full-load current of the machine. This being the case, the fact that these generators require a wattless current to excite them ceases to be a serious objection, and it is seen that the one important limitation of this type of machine is that it can not supply lagging wattless current to the outside circuit. Of course, the low-speed, sixty-cycle machines are relatively poor as regards power-factor and exciting current, so that the use of non-synchronous generators would not be advocated under these conditions, unless their other characteristics made them particularly advantageous for the conditions under which they were to be used. It will also be seen from Table I that another advantage of this type of generator is the extremely high efficiency at all loads that is obtained in high-speed machines. This means that these generators have a very low temperature rise at normal rated load, and that they have a very large overload capacity. The normal ratings of the individual machines given in the table were chosen so that their characteristics would be best at from one-half to one and one-quarter rated load. All the machines given can generate from two and one-half to five times their rated output, and as far as general characteristics are concerned could be rated up fifty per cent. It was stated above that the slip of the non-synchronous generator relatively to

the synchronous generator must increase from no load to full load in order that the former may carry its due share of the load. So if we wish the load always to be automatically divided between the two machines we must adjust the governor of the synchronous prime mover so that its drop in speed from no load to full load equals the drop in speed of the non-synchronous prime mover plus the full-load slip of the non-synchronous generator. This means that the speed and frequency of the synchronous generator must change with the load, but we see from the slip given in the table that this change is unimportant. The slip varies from 0.4 per cent to 0.75 per cent in high-speed machines and from 1.4 per cent to 1.8 per cent in low-speed machines, and this is about as close as the governors will regulate in any prime mover.

The greatest commercial field for the non-synchronous generator is undoubtedly in connection with turbine-driven generators. This type of generator is more suitable both mechanically and electrically for high-speed work than any other type of electrical machine. The squirrel-cage secondary with heavy copper bars, each bar held in a separate closed slot, and practically requiring no insulation, is an ideal construction mechanically, and is one which can be operated at very high temperature without damage. Comparing this with the rotating magnets of the standard synchronous turbo-alternator, the difference is very great. The magnet winding of a synchronous turbo-alternator consists of a number of turns of thin strap separated by insulation. The windings often reach high temperatures, due to overload at low power-factors, and are subject to heavy centrifugal stresses and a potential difference of 125 volts to ground. We can see that such a construction does not compare with that of the squirrel-cage rotating secondary of a non-synchronous generator. And as a break-down on the field of a synchronous turbo-generator usually puts the machine out of commission for a couple of weeks, we can see the mechanical advantages possessed by the non-synchronous generator. The simplicity in construction and insulation of the rotating parts, the ease with which the centrifugal stresses necessarily present can be taken care of, and the absence of a complicated winding and brush gear, necessarily tend to reduce the cost of the machine compared with that of the standard synchronous generator. Of course the actual cost of any machine depends on the performance specification to which it is designed, and on how closely the machine is rated, but it can readily be seen that the non-synchronous generator offers facilities for cheaper design and manufacture which are not presented by the synchronous generator.

TABLE I.

25-CYCLE TURBO-ALTERNATORS.

Kilowatts.	Rev. per Minute.	Volts.	Efficiency.			Power-Factor.			No-Load Current. Per Cent.	Slip. Per Cent.
			0.1	0.75	0.50	0.1	0.75	0.5		
1,000	1,500	2,200	97.6	97.7	97.5	97.0	97.5	97.0	8.3	0.75
		13,000				95.0	95.9	96.5		
2,500	1,500	2,200	98.2	98.2	97.8	97.9	97.3	96.4	8.3	0.48
		13,000				96.5	96.9	96.0		
5,000	1,500	2,200	98.3	98.2	98.0	98.0	97.7	97.4	8.5	0.46
		13,000				96.5	97.0	96.5		
10,000	750	2,200	98.5	98.4	98.2	98.2	98.0	97.5	8.1	0.40
		13,000				96.8	97.3	97.1		
60-CYCLE TURBO-ALTERNATORS.										
1,000	1,800	2,200	97.6	97.7	97.5	96.4	96.9	96.4	9.5	0.75
		13,000				94.0	95.0	94.5	11.5	
2,500	1,800	2,200	98.2	98.2	97.9	97.2	96.8	96.2	9.5	0.48
		13,000				94.5	95.3	94.8		
5,000	1,200	2,200	98.3	98.2	98.0	96.0	97.2	97.0	9.5	0.45
		13,000				94.5	95.6	95.5		
10,000	720	2,200	98.5	98.4	98.2	97.6	97.6	97.1	9.5	0.40
		13,000				95.3	95.6	95.5		
25-CYCLE GAS-ENGINE-DRIVEN ALTERNATORS.										
1,000	94	2,200	96.7	97.1	97.2	94.0	94.2	92.0	16.5	1.5
		13,000				89.3	90.9	88.7	18.0	
2,000	83	2,200	97.0	97.4	97.6	95.5	95.1	94.0	16.5	1.4
		13,000				92.4	93.2	90.7		
3,500	75	2,200	97.1	97.5	97.7	95.7	95.2	94.2	16.5	1.4
		13,000				92.6	93.4	91.0		
60-CYCLE GAS-ENGINE-DRIVEN ALTERNATORS.										
1,000	3	2,200	95.5	95.7	96.0	88.8	88.5	84.6	25.0	1.8
		13,000				83.0	81.0	73.3	40.0	
2,000	82	2,200	96.0	96.3	96.5	89.5	89.2	85.6	24.0	1.7
		13,000				83.5	81.8	75.0	38.0	
3,500	75	2,200	96.3	96.5	96.7	90.8	89.5	87.0	22.5	1.6
		13,000				85.0	83.3	77.0	35.0	

THE EXCITATION OF THE NON-SYNCHRONOUS GENERATOR.

A synchronous generator requires direct-current excitation, while a non-synchronous generator requires alternating excitation. The non-synchronous generator is excited by a lagging current taken usually from a synchronous machine, and as this synchronous machine requires direct-current excitation to produce this lagging current, it can be said that indirectly the non-synchronous generator does require a direct-current exciter. But on account of the small air-gap of this type of generator, it requires much less excitation than a synchronous generator. The actual capacity of the exciters which are required by a power station consisting of non-synchronous generators depends on the power-factor of the load on the system. The capacity required will usually vary from one-quarter to one-half of that which would be required for the corresponding synchronous generators. Of course, if we have a cable system with high electrostatic capacity, this will supply part of the required lagging exciter current and will reduce the size of the required exciter. The charging current of the New York Interborough system is about 105 amperes at 11,000 volts; that is, about 2,000 kilovolt-amperes, and that of the New York Edison system is about forty amperes at 6,600 volts; that is, about 450 kilovolt-amperes. We see from Table I that the capacity-charging current of the New York Edison system is sufficient to supply full-load magnetizing and wattless current required by a 2,000-kilowatt, 6,600-volt, twenty-five-cycle turbo-driven non-synchronous generator when running on a non-inductive external load. In the same way the capacity-charging current of the Interborough system would be sufficient to supply the wattless current of a 10,000-kilowatt, 11-000-volt, twenty-five-cycle turbo-driven generator. If we had a cable system such as the Interborough distributing at 20,000 volts, we would have a charging current of 190 amperes at 20,000 volts, which would be sufficient to supply the wattless component for 40,000 kilowatts in 22,000-volt, twenty-five-cycle turbo-driven non-synchronous generators. So we can see that the electrostatic capacity of a large cable

system will play an important part when we come to consider the introduction of such generators into some of the large New York power stations.

In a system consisting of non-synchronous generators supplying power to synchronous converters, it is unnecessary to have any exciters or synchronous machines in the power station. The first converter put-in circuit must be run up to speed from the direct-current side, and then thrown into the generator circuit, when it will excite the latter, and the voltage will be decided by the excitation of the converter. We can see from Table I that the power-factor of a non-synchronous generator can be made to remain practically constant from one-half to one and one-quarter load. This means that the amount of wattless lagging current taken by the generator throughout its normal working range will be practically proportional to the watt current. Hence, assuming that we can neglect the capacity-charging current of the cable system, if we have a number of converters running in the circuit, we can adjust the shunt excitation of each converter so as to give the correct voltage at no load, and the series excitation can be adjusted to obtain any desired voltage characteristic as the load comes on the system, the converters compounding the generators by their series winding. This compounding of the generators as the load comes on any substation affects, of course, all the other substations fed from those generators; so, if we are not regulating for constant voltage, it may be advisable in some cases to introduce artificial self-induction into the converter feeder circuits so as to over-compound the converter feeder circuits rather than the generators, and avoid disturbing the voltage on other unloaded substations. In a large system the capacity current of the cables can not be neglected, so the wattless current to be supplied by the converters will not be directly proportional to the load. Such a system usually requires constant voltage at the direct-current terminals, and in such cases it may be found advantageous to install compound-wound converters with automatic voltage regulators to control the shunt excitation. The voltage regulators would then serve to control the voltage of the generators and to keep that constant while the series winding would serve to compound each individual feeder in order to compensate for the voltage drop in that feeder. In such a system all the regulators controlling the voltage on a given group of generators would be tied together, so that any one regulator could not act before or act against the others, and make the shunt excitation of the individual converters different.

If there is no electrostatic capacity in the system, the power-factor of the converters is practically the same as the power-factor of the generators, but if there is capacity in circuit which helps to supply the lagging current, then the power-factor of the converters will be higher than that of the generators. Taking once more the Interborough system, and assuming there are 75,000 kilowatts of 11,000 volts, turbo-driven non-synchronous generators in the power station, and 75,000 kilowatts in synchronous converters in the substation, then the capacity current supplies thirteen per cent of the wattless current taken by the generator on full load, and we have a full-load power-factor for the converters of ninety-eight per cent. Such a power station of non-synchronous generators, having no direct-current exciters and exciting circuits, is much simpler as regards cables and switchboard connections than a similar station with synchronous generators, and is much simpler to operate. There is no necessity for synchronizing the generators; they are simply run up to speed and are then thrown on the line in series with a reactive coil (to limit the rush of current). The reactive coil is then short-circuited and the generators are automatically excited from the converters and take care of themselves. The governors of the prime movers are controlled by pilot motors from the switchboard, and the load can be distributed at will among the different generators without adjusting the excitation to keep the power-factor constant, as would be necessary with the synchronous generator. This gives an ideally simple station, as there are no auxiliary circuits, and the switchboard is practically limited to the main generator and feeder switches and instruments.

Synchronous generators and motors will give a greater sudden rush of current, or surge, in the case of short-circuit than almost any other class of machine. And though they have wave-forms which approximate closely to sine waves on no load, these wave-forms become so distorted by armature reaction on load, and change so with the magnitude and phase of the current, that there is an excellent chance of introducing such harmonics as will produce resonance. If we were deliberately to try to choose conditions which would be most liable to give trouble from high-power surges and resonance, we could not well choose anything that would be worse than synchronous generators feeding synchronous motors through a cable system of high capacity. The non-synchronous generator is a great contrast to the synchronous generator in this respect, as it tends rather to eliminate disturbances from the line than to originate them. A short-circuit on a system means that the voltage falls to zero, consequently any non-synchronous generator on the circuit becomes dead, and does not tend to supply either power, current or voltage to the short-circuit. Further, the wave-form of the electromotive force of a non-synchronous generator is virtually a sine wave for all loads, and it has no tendency at all to introduce higher harmonics which might produce resonance. If the synchronous machines supplying the wattless current in the circuit have a badly distorted wave-form, the magnetizing current of the non-synchronous generator

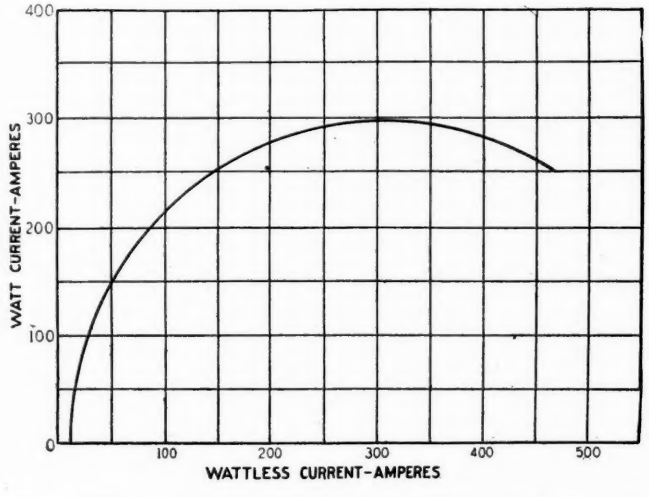


Fig. 1.—Relation of Watt Component to Wattless Component.

will also be distorted, but there will be a strong tendency to damp out all harmonics in the electromotive force wave-form of the system. And we can say that, generally speaking, the non-synchronous generator acts as a strong damper to remove all harmonics in the electromotive force wave-form of the system, introduced by distortion of the wave-form of the synchronous machines. This distortion in a synchronous machine, is due to the armature reaction of the watt component of the current rather than the wattless, so we see that the best conditions as regards freedom from distortion and harmonics are obtained by the use of a synchronous converter or unloaded synchronous machine rather than a loaded synchronous generator or motor to supply the wattless current required to excite a non-synchronous generator.

Fig. 1 shows the relation of the watt component to the wattless component of the current supplied by a 2,000-kilowatt non-synchronous generator, the curve being for its normal rated voltage of 11,000 volts; for a different voltage the values of current, both watt and wattless, should be multiplied by the direct ratio of the new voltage to 11,000 volts. We can see from this that the magnitude of the watt current bears a definite relation to that of the wattless, and that the watt current and consequently the load on the machine, can not change without the wattless current also changing. Further, for each point on the curve, the slip of the non-synchronous generator ahead of the synchronous machine has a certain definite value. This shows that when a short-circuit comes on a system consisting of a non-synchronous generator and synchronous generator or motor, the short-circuit will come on the synchronous machine. If the voltage drops to zero, the non-synchronous generator will be dead; but if the short-circuit is not severe enough to reduce the voltage of the system to zero, then it may still supply current to the circuit. The amount which it supplies will depend on the way in which the excitation of the synchronous machines is changed by the automatic voltage regulators. But a change in load which can be taken care of by the voltage regulators, hardly comes under the class of short-circuits, and as these latter effects are the only serious ones, we will consider them alone. We see from the above that the non-synchronous generator takes no part in the sudden surge of current which occurs on a short-circuit, so that this surge can not be greater than that which is supplied by the synchronous machines in circuit.

A short-circuit on a system consisting of the Manhattan generators supplying power to synchronous converters will give, on sudden short-circuit, a rush of current equal to eighteen times the total full-load current of the generators in circuit, while after a short period the value of the short-circuit current will fall to about one-fifth of this value. Assuming now that we had non-synchronous instead of synchronous generators in the power station, the short-circuit current would be limited to that from the converters, and the sudden surge would be equal to three times full-load current. The voltage of the system would fall to zero, and the converters would supply a gradually decreasing current to the short-circuit until their rotational energy was all expended, and they had come to rest. We see then that with non-synchronous generators in the power station the magnitude of the sudden surge on a short-circuit would be reduced to one-fifth of that which would take place with the present synchronous generators. This means that the voltage rise would be only one-fifth and the power of the surge would be only one-twenty-fifth. These figures do not need any comment.

There is one point, however, that must be considered when operating non-synchronous generators on the system containing considerable electrostatic capacity, and that is that the individual generator units are not too small. A non-synchronous generator can be excited by the lagging current from a condenser and the voltage to which it will be excited depends on the size of the condenser. In a system consisting of non-synchronous generators and synchronous machines we might, as the result of opening circuit-breakers by line disturbances, have just one generator and one small synchronous unit left running on the line. The capacity-current of the cable system would then tend to build up the voltage of the machines until the saturation of the magnetic circuit prevented any further rise. Taking the 2,000-kilowatt, 11,000-volt non-synchronous generator, the current curves of which are shown in Fig. 1, the magnetizing current at 11,000 volts is nine amperes. If the capacity-charging current of the cables is 100 amperes at 11,000 volts, and the synchronous machine is so small as to take a negligible lagging magnetizing current, it would probably mean that the voltage of the machines would build up to double the normal. If, however, the smallest machine on the circuit were a 10,000-kilowatt generator, a 1,500-kilowatt synchronous motor or synchronous converter, the rise in voltage would not be more than ten per cent; if the minimum size generator unit had been 20,000 kilowatts there would be no rise in voltage; so that this is a condition which can be taken care of when laying out the station.

Distortion of the wave-form introduces higher harmonics, and may cause resonance or cross-currents. In a synchronous generator or motor, the wave-form of the magnetism is usually badly distorted as the load comes on the machine, this distortion being greater the higher the power-factor, and the greater the load. This distortion of the magnetic waves introduces higher harmonics into the wave-form of the electromotive force generated in the armature conductors. The most important harmonic introduced is the third; but the fifth, seventh, ninth, and higher harmonics are also usually presented. In a three-phase winding, the third harmonic, and also harmonics of this third harmonic, appear in the electromotive force between the neutral and outer terminals, but not in the electromotive force between the outer terminals. They therefore appear in a three-phase, four-wire system or in a three-phase system with grounded neutral. The other harmonics appear, no matter what the connections are. Though the presence of these harmonics may not cause harm in any individual case it is always possible that there may, under certain conditions of circuit and load, be harmonics of a frequency sufficiently close to that of resonance to cause serious rise of potential. And if generators of different characteristics run together, or if there are loads of different magnitude and phase, or there is different excitation on the synchronous generators or motors, cross-currents are liable to be produced between the machines; this is especially the case in running with a grounded neutral. Synchronous converters are very much better than any other class of synchronous machines as regards distortion of wave-form when operating with unity power-factor; they have practically no armature reaction, and the electromotive force wave generated under such conditions is approximately a sine. So the above remarks on synchronous generators and motors only apply to synchronous converters to a limited extent.

Non-synchronous generators have no distortion of field due to armature reaction, and so long as the iron in the magnetic circuit is not saturated the electromo-

tive force wave-form of these generators is virtually a sine wave for all conditions of load. This means that there can be no cross-current between non-synchronous generators, and that they have no tendency to produce resonance in the circuit. Furthermore a non-synchronous generator acts as the strongest possible damper in a circuit, and if there is any surge, unbalancing of phases, distortion of wave-form or hunting present, the non-synchronous generator will tend to damp it out, and to restore the original condition of steady sine-wave operation. If we then have a system consisting of non-synchronous generators supplying power to synchronous converters it would be as nearly perfect as possible in its freedom from surges and resonance. The synchronous converter would give the minimum distortion of any synchronous machine, and the non-synchronous generator would tend to damp out any disturbance that occurred on the line. Such a system would certainly be very much superior to the synchronous generators and synchronous motors in regard to liability to disturbances from resonance and surges, and in all probability the engineers of such a system operating with grounded neutral would hardly know that such phenomena existed.

I have endeavored to show that the non-synchronous generator is very much superior to the synchronous generator from almost every point of view, for the purpose of supplying power to motor-generators and synchronous converters through an underground cable system, and that synchronous converters are less liable to introduce line disturbances than synchronous motors. In some cases it might be considered advisable to install both synchronous and non-synchronous generators, or the station might be one in which the units first installed were synchronous generators, and the later extensions were non-synchronous generators. In such cases it is readily seen that the advantages as outlined above are obtained to a degree which depends on the ratio of the number of non-synchronous to the synchronous generators. It should be remembered that the non-synchronous generator and synchronous converter give the best combination to insure freedom from line disturbances, and that the synchronous generator and synchronous motor give the worst; combinations of the two systems lie between these two.

With smaller power stations which supply power direct to motor and lighting circuits, the conditions are not so favorable to the non-synchronous generator, as this generator is primarily one for high power-factor loads, and it is at a distinct disadvantage in a station in which the load is of low power-factor. The advantages of the non-synchronous generator as outlined above are, however, so great that each particular case should be considered to see whether it will allow of its use. Usually the load on such a station having low power-factor consists mainly of motors during the daytime, whereas the heavy peak load is the lighting load at night. We can therefore install synchronous generators sufficient to carry the day motor load, and non-synchronous generators to assist in carrying the lighting load at night. Let us take a sixty-cycle station with a day load of 2,500 kilovolt-amperes which will probably have a power-factor of seventy per cent and a night load of 4,000 kilovolt-amperes with a power-factor of ninety-eight per cent. And assume further that we have two 1,250-kilovolt-ampere synchronous turbo-generators to carry the day load, and two 1,000-kilovolt-ampere non-synchronous generators to assist in carrying the night load. This night load consists of 3,850 watt kilovolt-amperes and 800 wattless kilovolt-amperes, and the two non-synchronous generators require in addition 980 wattless kilovolt-amperes to excite them. We shall then have the two synchronous generators carrying a load of 2,500 kilovolt-amperes at seventy per cent power-factor and the non-synchronous generator carrying a load of 2,250 kilovolt-amperes at power-factor 0.98.

It is nearly always more economical to supply wattless current in a power station from unloaded high-speed synchronous motors than from the main synchronous generators. This is more especially the case with steam-turbine or very slow-speed units, as such machines can not be economically designed with the good regulation and the margin on the fields necessary to handle properly a low power-factor load. Such a machine to carry satisfactorily a certain kilowatt load at power-factor seventy per cent will be about double the size of a unit to carry the same kilowatt rating at unity power-factor. In the station considered we have assumed that the synchronous generators supply all the wattless current required for the non-synchronous generators and outside circuit. It would be better, however, to make the synchronous generators 1,000 kilovolt-ampere units with poor regulation, and install also a 1,500-kilovolt-ampere high-speed synchronous motor to supply all the wattless current. This should give a cheaper and more flexible installation, as we would be able to run the non-synchronous generators without the synchronous generators at any time, using the synchronous motor to excite them. The non-synchronous generators would require no direct-current exciters, exciting circuits, or switch panels; they would probably be cheaper than the synchronous generators, and would be simpler to handle, and less liable to break down. So we can see they have such important advantages that they should be carefully considered in each individual case before deciding to adopt synchronous generators alone.

OTHER APPLICATIONS OF NON-SYNCHRONOUS GENERATORS.

In the above remarks the non-synchronous generator has been dealt with more especially as a steam-turbine-driven unit for generating alternating current. This type of generator, however, often presents important advantages for other and more especial conditions. Two of the most important of such cases are gas-engine-driven alternators and steam-turbine-driven direct-current units. The advantage of the non-synchronous generator for gas-engine-driven units is of course that it does not require the extreme uniformity of speed required by a synchronous generator, and the advantage of its application for direct-current generation by turbine units is, that by the use of a non-synchronous generator and synchronous converter we can avoid the use of a direct-current turbo-generator.

GAS-ENGINE-DRIVEN UNITS.

With the modern tandem and twin-tandem gas engines, giving respectively two and four impulses per revolution, gas-engine-driven alternators can undoubtedly be run in parallel. But to obtain the same kind of satisfactory operation that is obtained with steam engines, enormous flywheels and heavy dampers on the pole-faces of the alternators are necessary. Such flywheels mean a considerable increase in cost, and sometimes in the floor space taken up by the engine, and also a loss in efficiency due to the increased bearing friction and windage. And there is necessarily a considerable loss in the dampers on the pole-faces of such a gas-engine-driven alternator, because the irregularity of speed in a gas engine is such compared with that obtained in a steam engine that the dampers have to perform heavy work in accelerating and retarding the flywheels. We can readily see that there can be easily an increased loss of three per cent to five per cent from these two causes, which would not be detected except in a gas-consumption

test, when running in parallel with other units. Instead of synchronous units we can install non-synchronous generators and have high-speed synchronous motors running light, to provide the necessary lagging current for the outside circuit and for exciting the generators. In this case any change in load comes first on the synchronous motors, causing a change in their speed, and in consequence a transferring of the change in load to the generator. And as the voltage of the generator would be decided by the excitation of the synchronous motors the voltage regulation of the station is that of the synchronous motors. Hence for constant potential it may be advisable in some cases to control the excitation of all the synchronous motors by one automatic voltage regulator. The size of the direct-current exciter necessary for the synchronous motors would depend on the power-factor of the load on the station, and would be greater the greater the lagging current required by the external circuit. Generally speaking the size of the exciter required would be from one-quarter to one-half of that necessary for the corresponding synchronous generators. The probable arrangements would be a direct-connected exciter on each synchronous motor, which could also be used as a starting motor; and one gas-engine-driven exciter would also have to be installed for starting up the first synchronous motor.

Taking as the load on such a 2,200-volt, twenty-five-cycle power station, 20,000 kilovolt-amperes at seventy per cent power-factor, we would have from 5,000-kilovolt-amperes, seventy-five revolutions per minute synchronous generators, each requiring a 125-kilowatt exciter; or from 3,500-kilowatt, seventy-five-revolutions-per-minute non-synchronous generators, together with from 4,500-kilovolt-ampere, 500-revolutions-per-minute synchronous motors with sixty-kilowatt direct-coupled starting motor-exciters. Each synchronous motor would supply the 1,000-kilovolt-amperes exciting current required by one non-synchronous generator, together with 3,500-kilovolt-amperes wattless current for the external circuit. The relative efficiencies on the load of seventy per cent power-factor are as follows:

	Synchronous Generator.	Non-Synchronous Generator and Synchronous Motor.
Full load	95.7—(a)	94.0
0.75 "	95.1—(a)	93.6
0.50 "	94.0—(a)	92.5

These efficiencies do not take into account the allowance (a) to be made for additional losses due to the increased friction of the larger flywheels, and the losses in the dampers or solid pole-faces which occur with the gas-engine-driven synchronous generator. These additional losses will reduce the efficiency of the synchronous generator below that of the non-synchronous generators set. The cost of the electrical equipment would not be very different in the two cases, and as the larger flywheel shaft and bearings required for the synchronous generator would increase the cost considerably, it is probable that the non-synchronous generator equipment would be found a good deal the cheaper. It must be remembered that this is an extreme case, because the low power-factor of seventy per cent taken for the outside load is very much against the non-synchronous generator. If the power-factor were higher the result would be much better.

It might be supposed that unless we had very heavy flywheels on the gas engine we would have the same trouble with hunting of the non-synchronous generator and synchronous motor that we would have with the synchronous generator. But such is not the case. There will undoubtedly be cross-currents between the machines, the magnitude of which will depend on the variation in the speed of the gas engine, but it will be practically impossible to break them out of step. The worst effects of this interchange of current between the machines will be the heating and losses in the armature conductors, and the pulsation in voltage due to the interchange of wattless current. This pulsation of voltage will be diminished by dampers on the pole-faces of the synchronous motor, but it will usually be perceptible when only one generator is running. As these gas-engine-driven units will be used mainly for power work in mills the slight pulsation of voltage will be unimportant.

Non-synchronous generators are not put forward as the only possible solution of the gas-engine-driven alternator question; but as the most practical, and that which will recommend itself most highly to the conservative power-station engineer and manufacturer. It is by no means settled that extremely heavy flywheels and powerful dampers are a practical and advisable solution of the parallel running difficulties.

STEAM-TURBINE-DRIVEN DIRECT-CURRENT UNITS.

The other special case for the use of the non-synchronous generator above referred to—the use of such a generator, together with a synchronous converter for the production of direct current—is to meet the special case in which a steam turbine is desired as a prime mover. Reasons which might compel the choice of the steam turbine are numerous: small overhead space, small floor space, poor foundations, objection to the vibration of reciprocating engines, high steam economy required over a wide range of loads, reduced maintenance and supervision—all these might influence the choice of prime mover. And as the direct-current turbo-generator, particularly for 250 and 125 volts, has as yet hardly established its position as a conservative and reliable machine, some kind of alternating-current generator would be used in combination with a motor-generator or synchronous converter. Two years ago an electric railway and light company wished to install an auxiliary 3,000-kilowatt, 300-volt, direct-current, steam-driven generating equipment in the basement of their new public-service building. As the head-room was limited to about twelve feet, and as the vibration would be objectionable, reciprocating engines were out of the question. It installed two 1,500-kilowatt, horizontal, steam-turbine-driven synchronous alternators, and two synchronous motor-generator sets. This would have been an ideal case for a non-synchronous generator and synchronous converter. The converters could be started from the direct-current system, and when up to speed would have excited the non-synchronous generators; no exciters nor exciting circuits would be necessary, the voltage being controlled by the excitation of the converters. The equipment installed has a combined full-load efficiency of about eighty-six per cent, while the combined efficiency of a non-synchronous generator and synchronous converter to do the same work would have a full-load efficiency of about ninety-five per cent. In addition it would probably have cost about one-third less.

In comparing a turbine-driven non-synchronous generator and synchronous converter with a steam-engine-driven direct-current generator, the former is found to be a more flexible equipment, one which will carry heavier overloads and is usually cheaper. We can obtain any compounding desired by means of a compound winding on the converter, and by use of transformers we can have converters of different voltages to supply different direct-current systems. We can place the converter at a distance and transmit the power

to it at a high voltage, or we can split up or arrange the equipment as we please. The efficiency is slightly higher on the non-synchronous generator equipment than on the engine-type, as can be seen from the following table of full-load efficiencies for 270-volt generators:

	1,000 Kilowatts.	2,000 Kilowatts.	8,000 Kilowatts.
1. Non-synchronous generator.	97.5	98.0	98.25
2. Synchronous converter.....	97.0	97.5	97.75
3. Combined efficiency of non-synchronous generator and synchronous converter....	94.5	95.5	96.0
4. Engine-type.....	93.5	94.25	94.5

There are many indications that the day of the large engine-type direct-current generators is past. The inaccessibility of the brushes, the difficulty of building and maintaining a commutator of large diameter, and the numerous other drawbacks of this type of machine, have caused it to be regarded as an undesirable addition to a power station. It is a question whether the non-synchronous generator and the synchronous converter are not superior to the engine-type direct-current generator in almost every case, and it should always be carefully considered when a new direct-current station is laid out, or when any extensions are added to existing plants.

I have endeavored to show that the one great disadvantage of the non-synchronous generator—its inability to carry a lagging wattless current load—should not always prevent its successful adoption. And that the important advantages it possesses—its excellent mechanical construction, high efficiency, good characteristics in regard to short-circuits and resonance, strong balancing and damping action, absence of rotating windings or collector rings, absence of direct-current excitation and exciting circuits, ease of parallel running, facility for control of load by governor, and general simplicity. and flexibility of operation—all these make it in many cases by far the most advisable machine to adopt. The non-synchronous generator suffers from the fact that it was judged and condemned in the early days of electric-power-generating stations. At that time there was no real field for this generator, but the introduction of steam turbines and gas engines, and the modern development of large power stations have so fundamentally altered conditions that the non-synchronous generator is no longer an interesting curiosity, but one of the most promising types of generator for power-station equipment. The record of three years in service places this machine on a demonstrated commercial basis, and while it may have limitations it possesses so many advantages and its sphere of usefulness is so large, that in the opinion of the author it must be acknowledged to offer greater future possibilities than almost any other type of power-station equipment.

Pittsburg Section American Institute of Electrical Engineers.

On February 5 the Pittsburg (Pa.) section of the American Institute of Electrical Engineers held a meeting in the Carnegie Institute Lecture Hall after an informal dinner at the University Club. Several original papers were read and discussed, a short summary being given below.

Henry W. Fisher, of the Standard Underground Cable Company, read a paper on "Varnished Cloth Insulated Cables," which was very interesting and instructive. While most of the processes of manufacture are still secret, Mr. Fisher gave some good data. The samples of cloth are made in thicknesses varying from five to sixteen mils. The specific gravity of varnished cloth is very close to one, and while the electrical properties of different makes vary widely, some average tests made on samples a circular foot in area showed as follows: Insulation resistance from a few megohms to 955 megohms; alternating electrostatic capacity from 0.11 to 0.26 microfarads; break-down electromotive force from 120 volts to 860 volts. The power-factor of varnished cloth is an important consideration. One sample when tested with 20,000 volts for two hours became very hot, while a similar sample of another kind was perfectly cool after a similar test. Mr. Fisher exhibited a number of samples of varnished cloth cables, some lead-covered and others covered with an asbestos braid for switchboard work.

A. B. Reynders, of the Westinghouse Electric and Manufacturing Company, explained the great variety of uses varnished cloth is put to in modern electrical machinery. As an insulation for curved surfaces it stands alone. He also explained the different processes of its manufacture and stated that when finished it would stand a voltage of from 800 to 1,200 volts per mil of thickness. The methods of inspection and testing are important, to see that the cloth will stand bending and creasing without breaking down. The testing surfaces should be flat discs. The cloth should stand baking at high temperatures for a number of hours without being injured. A temperature of 300 degrees Fahrenheit or over will injure the mechanical strength of the cloth.

G. A. Jacobs, of the Sherwin-Williams Company, expounded the technical requirements of varnish in varnished cloth. He called attention to the fact that it was impossible to have a quick drying varnish that will remain permanently elastic. A varnish should never lose its life and elasticity when used at temperatures below 180 degrees Fahrenheit. He said that most oxidizing or drying agents keep on working and drying out after the process was supposed to be stopped and for that reason alone the varnish lost its elasticity with age. Hot air is one of the most reliable oxidizing agents. Varnished cloth should also possess a tackiness which is useful in making it adhere to itself.

Dr. Riddle read a paper for James Todd, of the Sterling Varnish Company. Mr. Todd believes that the mechanical properties of varnish-insulated cloth are just as important as the electrical properties. A cloth should be given an endurance test as well as a quick-puncture test. Varnished cloth is best when made up of a succession of layers dried one on top of the other. Some kinds of oil tend to rot the cloth. Linseed oil should be purified before being used.

In a general discussion of the subject S. P. Grace, chief engineer of the Central District and Printing Telegraph Company, called attention to a varnished-cloth insulated cable several miles long, used by the Pittsburg Railways Company for carrying a three-phase current of 13,000 volts from Brunots Island to Bellevue. This cable is hung aerially, without lead sheathing, and has been working for several years without giving any trouble, with the exception of one splice that was improperly made. He considered this an important stride onward in the art of high-tension power transmission. He also spoke of trying varnished-cloth distributing wires for telephone service.

Paul Lincoln called attention to the use of varnished-cloth insulated cables as a protection against breakdowns caused by electrolysis.

B. P. Rowe, who has charge of switchboard design for the Westinghouse Electric and Manufacturing Company, called attention to the advantages of using varnished-cloth insulated cables with asbestos covering for power switchboard work and short duct runs. He called attention to the great permanency of everything about a switchboard except the reliability of insulation on cables. He thought this should be made as permanent as the barriers they build for protection. He spoke of the advantage of doing away with bells on cables without lead covering.

C. E. Skinner, of the Westinghouse Electric and Manufacturing Company, thought that the varnished-cloth insulated cable with an asbestos covering was a great point when considering the fireproofing of wires. He also spoke on the subject

of the manufacture of varnish, calling attention to the three principal methods of oxidizing linseed oil. These agents consist of, first, heated air; second, borate of manganese; third, oxide of lead.

R. D. De Wolf and O. A. Sandborgh, of the Westinghouse Electric and Manufacturing Company, gave some data regarding power-factors and weakness of varnished cloth with rise of temperature. Some linseed oils under test show a power-factor of fifty per cent and other oils show as low as one per cent.

S. Wilson, of the Union Switch and Signal Company, spoke highly of varnished-cloth insulated signal cables which he has been using for some time. They are absolutely unaffected by oil.

Washington, Baltimore & Annapolis Electric Railway Put in Operation.

The Washington, Baltimore & Annapolis Electric Railway Company put its line into operation on February 7 between Washington and Annapolis. At the same time it was announced that the section lying between Baltimore and Naval Academy Junction, formerly Odenton, will be ready for operation in about a month. A number of railroad men and representative men from Baltimore made an inspection trip over the road as guests of the officials of the company. The trip between Annapolis and Washington was made in nineteen minutes.

The car in which the trip was made was operated by T. M. Childs, of the General Electric Company, who has acted as superintendent of construction in electrifying the road. He was assisted by Harry Farquhar.

Franklin Institute Reception.

A reception was given by the board of managers of Franklin Institute, at the institute building, 17 South Seventh street, Philadelphia, Pa., on Friday evening, February 14. The programme included an address in the lecture room by Persifor Frazer, on "The Franklin Institute, Its Services and Deserts." After the lecture a demonstration of the "Electrelle" was given, and moving pictures shown at intervals. There was a reception given in the reading room, and exhibits of models and photographs, followed by music and light refreshments. There were also exhibits in the school room of drawings by the students of the institute.

BOOK REVIEWS.

"The Hughes and Baudot Telegraphs." Arthur Crotch. London. S. Rentell & Company, Limited. Cloth. 84 pages. Illustrated. 5 by 7½ inches. Price, 1*s.* 6*d.*

A detailed description is given here by the author, who is a member of the engineers' department of the General Post-Office of Great Britain, of the two printing-telegraph systems—the Hughes and the Baudot. The principles of each are described and the methods of construction and of operation are explained.

"Harper's Electricity Book for Boys." Joseph H. Adams. New York. Harper & Brothers. Cloth. 408 pages. 6 by 8 inches. Illustrated. Furnished by the ELECTRICAL REVIEW for $1.75.

This book will make a fine gift for the young mechanic, but will hardly more than give him a very crude idea of electrical apparatus. Of course, the author has been careful to suggest such forms of electrical devices as might be readily constructed from material easily available. The work is well arranged and carries the student forward from apparatus easily put together to the more elaborate machines which require more advanced mechanical ideas and a greater knowledge of electricity in general. There is added a chapter on electric light, heat and power, by Joseph B. Baker, which refers very briefly to some of the modern utilizations of electricity.

"Neuere Elektrophysikalische Erscheinungen." Part i—Applications of Telegraphy and Telephony. Ernst Ruhmer. Berlin. F. & M. Hartwitz. Administration der Fachzeitschrift, der Mechaniker Paper. 214 pages. 215 figures. 7 by 10 inches. Price, 4*m.*

In this brochure the author brings together his various writings on telegraphic and telephonic subjects. He deals first with the various new telegraphic systems, beginning with the Wheatstone and including those of Delany, Pollak-Virag, Crehore & Squier, Murray, and the Siemens & Halske printing system. He then takes up the duplexing and multiplexing systems of Mercadier, Meyer, Delany, Baudot and Rowland. These descriptions are followed by a discussion of submarine cable systems and then by one on a number of printing-telegraphic systems. The telautograph is taken up, the various types of this instrument being described in some detail. Following this the copying systems for reproducing pictures are described, including those of Bakewell, Caselli, Hummel, Palmer and Korn. The volume closes with a chapter on telephone systems, including the ordinary types of instruments, loud-speaking instruments, systems for transmitting music, the telegraphone, the Pupin long-distance system, and two automatic systems, those of West and Strowger. In each case the description gives not only the principle on which the system operates, but also a detailed discussion of the important features of construction. The volume contains a great deal of useful information dealing with the newer systems of transmitting intelligence.

"Plane Surveying." Alfred E. Phillips. Chicago. American School of Correspondence. Cloth. 208 pages. 6¾ by 9¾ inches. Illustrated. Furnished by the ELECTRICAL REVIEW for $1.50.

This is a very practical working guide and gives many suggestions for working along the most approved modern lines. It must be understood that this is one of a series of volumes especially adapted for self-instruction and home study. While the student may lose much erudite mathematical treatment, and will not be rehearsed in heavy technical terms and made acquainted with all kinds and conditions of mathematics, for the ordinary young man who desires to know enough about plane surveying to get himself well started on his work, the volume will be found of interest and value. The method of taking up the work, the descriptions of the instruments and the purposes and functions of the various surveys made are clearly defined, and it would seem that any intelligent young man could grasp all this and determine whether it would be well for him to continue the subject under more advanced conditions.

"Electrical Instruments and Testing." N. H. Schneider and J. Hargrave. New York. Spon & Chamberlain. Cloth. 240 pages. Illustrated. Furnished by the ELECTRICAL REVIEW for $1.

In this, the third edition of this descriptive treatise of electrical instruments and measurements, the volumes has been enlarged and otherwise improved. This book is intended for the practical man, though it is arranged to serve as an introduction to more elaborate studies of the subject. The tests chiefly dwelt upon are those which occur in the daily work of the engine room, power-house, or technical school. By avoiding too detailed descriptions of the apparatus a considerable saving is effected, and the ground is covered in a reasonable space. This is a good feature, since such information is best obtained by an examination of the instruments and apparatus themselves. The first section of the book—that which deals with the instruments in general testing—has been prepared by Mr. Schneider, and Mr. Hargrave's contribution consists of a number of chapters dealing with the testing of wires and cables and locating faults.

The Application of Electric Power to Pulp and Paper Mills—The Watab Pulp and Paper Company's Mill.

By LeRoy M. Harvey.

THE wonderful progress made in the last decade, particularly during the last five years, in the application of electricity as a motive power to all branches of commerce and industry has awakened the interest of the whole manufacturing world to its possibilities, and the paper-mill operator, like his brother manufacturers in other lines, is to-day making a conscientious investigation into the results to be secured by the application of this power to his own particular branch of industry.

The scheme of power transmission which has prevailed in paper mills has a parallel in that to be met with in any other factory of equal or greater size not already equipped with electric motors. A distinguishing difference, however, between the paper mill and the other types of factories is found in the fact that in possibly no other industrial establishment is the percentage of losses due to an inefficient system of power transmission so great as in the paper mill; and, as a consequence, in no other type of industrial establishment is the percentage of saving resulting from electrical equipment so large.

No line of improvement in paper-mill equipment will contribute more to the securing of low cost of production and high-grade output than the adoption of the electric system of power transmission. This is a very broad statement, but it can be substantiated by a careful investigation of the results obtained from mills which are actually equipped with the electric system. Naturally, the first question which arises in the mind of the mill operator is: Wherein will the use of electricity as a motive power lead to lower cost of production and a higher-grade output? The answer to this question is found in a number of primary effects resulting directly from the use of the motor drive, each one of which bears its part in securing the final result above mentioned. These primary effects may be classified as follows:

(1) Reduction of transmission losses, (2) greater reliability, (3) greater elasticity, (4) reduced cost of maintenance, (5) steady speed throughout the mill, (6) ideal conditions for the paper machine, (7) saving in space, (8) decreased chance of injury to employés, (9) greater cleanliness.

REDUCTION OF TRANSMISSION LOSSES.

In every mill with the old-style equipment the quantity of belting, pulleys, hangers and shafting is appalling, and the losses of transmission through this complex system are very large. Actual tests show that these losses, which are usually termed friction losses, vary from forty to sixty per cent of the power delivered at the engine or water-wheel shaft; fifty per cent being a very fair average. This figure, of course, does not apply to the grinders or the beater shaft when driven direct, as is usually the case. The more complex the system of shafting and belting becomes, and the greater the distance of transmission from the source of power, the more rapidly does the percentage of friction loss increase. In comparison with this we are able, with the electric system, to transmit power from the shaft of the prime mover to the shafts of driven machines with an average loss of from twenty to twenty-five per cent, from three to five per cent of this being in the wiring and the balance in the generators and motors. Moreover, we reduce the loss to this low point regardless of the complexity of the system or the distance of transmission. Distance enters into consideration only in so far as it affects the size of the wire required to transmit a given quantity of power. In practice five per cent is considered a commercial allowance for installations of this character.

It is evident from the above that in the power transmission alone a saving of from fifteen to forty per cent, depending on the conditions to be met with in each individual case, can be effected by the use of the electric system. A modern two-machine mill, with the prevailing tendency toward large-size machines, will require outside of the grinders from 1,500 to 2,000 horse-power. Assuming the minimum saving of fifteen per cent on this, we shall have a net gain of from 225 to 300 horse-power, a very considerable sum when reduced to the basis of dollars and cents. In a steam-driven mill this saving would be represented by the decreased consumption of fuel; in a mill where water is the prevailing power the saving will appear in the additional volume of water available for grinding pulp, or for extensions; and in these days pulp is a very valuable asset, which can always be marketed to mills that are unfortunate enough not to possess sufficient water power to grind their own pulp.

The equipment of the new mill of the Watab Pulp and Paper Company, near St. Cloud, Minn., affords a striking example of minimized transmission losses. A visitor to this mill can not help being impressed by the entire absence of the usual shafting and belting.

GREATER RELIABILITY.

Where the operation of any particular machine or line shaft is dependent upon that of a number of other shafts, with many belts intermediate between this machine and the prime mover, there is always the liability of an entire shutdown, due to the failure of one of the intermediaries. In a paper mill this possibility is increased by reason of the fact that many of the belts are large and very heavy, causing a great strain to be put upon the shaft, hangers and pillow blocks and resulting in throwing the shafting out of alignment and heating the journal boxes, to say nothing of breaking the belts themselves. It should not be forgotten, either, that a shaft out of alignment rapidly increases the friction losses.

With the electric system there are no intermediaries. Each motor, with the machine or shaft which it drives, is really a separate unit, and, as the failure of the wiring is a most unusual occurrence, is dependent on nothing but the operation of the prime mover itself. In regard to the reliability of electric generators and motors, the best evidence of the high esteem in which they are universally held is found in the great and constantly increasing number of factories in all lines of industry which are operating under the electric system. The motor troubles, of which we occasionally hear, are in nearly every case directly traceable to poor engineering in laying out the installation or to negligence on the part of those employed to look after the electrical apparatus.

GREATER ELASTICITY.

The term elasticity as applied to an electric system of power transmission is

intended to convey the idea of easy expansion and application to all of the many power problems encountered in the modern mill or factory. If the mill operator wishes to install new apparatus he does not have to stop to figure out how he is going to get power to the new machines.

Another phase of this same elastic system lies in being able to distinguish between the different types of power service required throughout the mill and to treat each individual case on its merits and in the manner calculated to secure the highest efficiency of operation. We have constant-speed motors for constant-speed work, variable-speed motors for variable-speed work, elevator motors to drive the elevators and crane motors to operate the cranes. In the old system it was always a case of belting; but with the electric system we can either direct connect, gear or belt the motor to the driven machine, as may seem best. In general, for paper mills, it is better to couple direct wherever this can be done without too great an investment in the motor by reason of the necessity for very slow speeds. The scheme usually followed is to direct connect the centrifugal pumps, Jordans, barkers, log saw and variable-speed shaft of the paper machines; gear all duplex or triplex pumps, rotaries, calenders and wet machines; gear or belt the conveyers, rag dusters and cutters; and belt the beaters, elevators and all group drives. The grinders it is better to couple direct to the water-wheel shafts (although there are some enthusiasts who favor driving these also by direct-connected motors). The equipment of the Watab Mill, previously referred to, is carried out along these lines and the results have been most gratifying.

REDUCED COST OF MAINTENANCE.

Every one who has had experience with a complicated system of belting and shafting well knows what it means to keep it in running order. In the average paper mill much of the time of the millwright and his assistants is required for this work. A broken or stretched belt, a short belt that refuses to pull right until it is so tight that the journals heat, belts that run off because they have to round a corner, and bolts that wear because they are twisted; journals that heat because of the great lateral strain put upon them by very heavy or very tight belts; shafts thrown out of alignment by these same strains—in short, something continually happening to claim the repair man's time and try the patience of the operator as well as draw on his bank account.

Contrast the above with the situation in an electrically equipped mill where shafting is practically eliminated. The chief engineer and his assistant can easily take care of the electrical apparatus, for all they have to do is to see that the bearings of the motors and generators are properly lubricated, and, in case the equipment is of the direct-current type, to keep the commutators clean and the brushes properly adjusted. With alternating-current motors, which have no commutators, there is nothing to require attention but the bearings. Burn-outs in the windings of the motors are practically unheard of, but even if they should occur, the motor can be repaired in less time and with less expense than is required to restretch a broken belt or replace a melted-out journal. The services of at least one man, and possibly two or three, are saved outright and there is practically no expense for supplies, as none are required except for extensions after the installation is completed.

STEADY SPEED THROUGHOUT THE MILL.

One of the many drawbacks to the belt and shaft scheme of transmission lies in the constantly changing speed throughout the system. This change is not due so much to variation in the speed of the prime mover as it is to the effect of starting and stopping the various shafts or machines comprising the system. A heavy load, thrown on or off in this way, reacts upon the apparatus nearest to it on the system, instead of upon the prime mover, as it should. With an electric installation, however, the effect of starting or stopping any motor is carried back to the switchboard, which is connected directly to the prime mover, and, as the prime mover is always provided with a governing device to control its speed, the other machines on the system are not interfered with. There are many machines where a continued variation in speed becomes a serious matter, and at all such times such changes impair the running efficiency of the mill and tend to lower the quantity and quality of the output.

IDEAL CONDITIONS FOR THE PAPER MACHINE.

The paper machine itself is the very heart of the mill, and the successful operation of the auxiliary apparatus is of no avail if there is trouble at this point. Nothing contributes so much to the ideal conditions for operation as a steady speed, which can at the same time be readily varied, and uniform temperature in the steam which is used for drying. Both of these requisites are possessed by the electric system. For reasons explained in the preceding section, we derive from the prime mover an almost absolutely constant speed. This speed, through the agency of the variable-speed motor which has proven so satisfactory in service, can be varied at the will of the operator over a very wide range, and at the same time the motor maintains practically a constant efficiency. Variable-speed motors on paper machines, in actual operation today, have a ratio of speed change of two to one under these constant conditions of efficiency, and it is entirely practicable to get as high as three or even four to one. By the use of a controlling device and multiple voltage (although this slightly decreases the efficiency of operation) that ratio of speed change may be still further increased to six, eight or even ten to one. One of the most important features of the speed change lies in the fact that the successive increments of the change are very small; each step on the controller means a change of only one and one-half to two revolutions on the motors or on the variable-speed shaft to which the motor is coupled. The speed can be varied over the entire range without a shutdown, which means that the machine tender can change from one grade of paper to another, no matter how great a difference, without stopping the machine. The difficulties of maintaining a constant speed, when the machine is driven from an engine operated under a varying steam pressure and varying load, are too well known to require more than mention.

The single objection raised by some manufacturers to the electric system is with regard to the economy of the drive on the paper machine itself. They contend that as long as it is necessary to use steam for drying it would be better to drive the machines by engines and use their exhaust rather than drive by motors and dry by live steam. In a consideration of this point we should divide the mills into two classes: First, those whose initial power is water, and, second, those whose initial power is steam. Even the most ardent advocates of the use of steam engines and exhaust steam will admit the superiority of electric drive in the case of mills of the first class where ample water power is available for all purposes, for there can be no question that the generation of electric power from water is cheaper and more efficient than the generation of steam power from coal. The only argument, therefore, is with respect to mills of the second class, which must produce all, or a part, of their power from

steam. Many such mills, partially steam driven, could be placed in the water-power list by the adoption of the electric system, the power thus saved being equivalent to that produced by steam. Admitting, for the sake of argument, that in mills of the second class it is more economical to use engines on the machines—which contention is open to dispute—the many advantages of the electric drive, as described herein, are more than efficient to outweigh the possible saving in fuel. Moreover, we see no reason why the exhaust from the main engines driving the electric generators could not be used for drying if desired; and if this is done the question of economy is wiped out entirely. Another contention which has been advanced by paper manufacturers who are using the electric drives on their machines and live steam for drying, is that the use of live steam permits of maintaining a constant temperature on the dryers, resulting in a uniform sheet of paper of high finish, a condition which can not be as easily secured by exhaust steam on account of the varying pressure in the line. If the mill be driven by water power, no engines whatever will be required; if by steam, the engines will be used solely to drive the electric generators in the power-house. In either case the drying will be done by live steam taken directly from the boilers, and brought down to the proper pressure through a reducing valve. By this method we are assured of a constant pressure, which means a uniform temperature in the dryers of the machines. There is, of course, no reason, in a steam-driven mill, why the exhaust from the engines driving the generators can not be used for this purpose if desired, but if the drying is done with exhaust steam, it is almost out of the question to maintain a uniform temperature, as the exhaust frequently drops to so low a temperature that it is practically water and of little value for drying. Admitting, for the sake of argument, that it is cheaper to dry with exhaust than with live steam—which fact is open to dispute—the advantages of the live steam outweigh any possible saving in the use of the exhaust.

SAVING IN SPACE.

Doing away with so much shafting, with its accompanying array of pulleys, belts, hangers and pillow blocks, naturally relieves, to a great extent, the congestion which exists in the average mill. As the motors are mostly direct-geared or coupled, very little space is required by them, thus permitting the placing of the various machines close together, and at the same time affording ready access to all. As the result, a large floor space is available for the storage of stock, and for storage in such a manner as to afford ready access, not only to the stock itself, but also to adjacent machinery.

DECREASED CHANCE OF INJURY TO EMPLOYÉS.

The protection of the lives and limbs of his employés is, naturally, one of the first thoughts of a manufacturer, and yet hardly a day passes but that we read of some operative getting caught by a belt, pulley or shaft, and either losing his life or being seriously injured. Such accidents it is almost impossible to prevent where a system of shafting is in use—the two evils are coexistent. There is also a sequel to accidents of this character in the shape of damage suits which, under the employer's liability laws existing to-day, frequently results in large losses to the owners of plants. In a recent case of this kind the plaintiff—a mill hand—received a verdict of $15,000, which was confirmed by the Supreme Court.

GREATER CLEANLINESS.

In a paper mill cleanliness is of paramount importance, and nothing contributes more to a high-grade product than clean stock and a clean mill, particularly a clean machine room. Belts, pulleys and shafting are potent conveyers and disseminators of dust, dirt, grease and filth of all kinds, and the only safeguard against these evils is to do away with pulleys and shafting, which can be accomplished only by substituting electric drive.

As an illustration of what can be accomplished by the adoption of the system advocated in the preceding paragraphs, a brief description of the new mill of the Watab Pulp and Paper Company, referred to above, may be interesting. This mill is located on the Mississippi River, at Sartoll, Minn., a few miles above St. Cloud, and is one of the most modern and best-equipped plants of its kind on the American continent.

The mill buildings are all of the reinforced concrete and consist of a machine room and basement, seventy-two by 230 feet, a beater room and basement, forty by 122 feet; wood-room and basement, thirty-six by seventy feet; boiler house, fifty-eight by seventy-two feet; pulp mill, thirty-two by 152 feet; pump room, twenty by seventy feet, and power-house, thirty-two by seventy-two feet. The boiler room contains two Stirling water-tube boilers which furnish steam for heating the buildings and for drying the paper. All the power used in the mill, with the exception of that for the nine grinders, which are direct-coupled to water-wheels, is generated in the power-house, which is located near the centre of the river immediately adjoining the grinding room. A dam 600 feet long was thrown straight across the river and affords a head of approximately seventeen feet; the power-house and grinding room form a part of the dam, and the remainder consists of gates and spillway of the ordinary crib construction—rock filled.

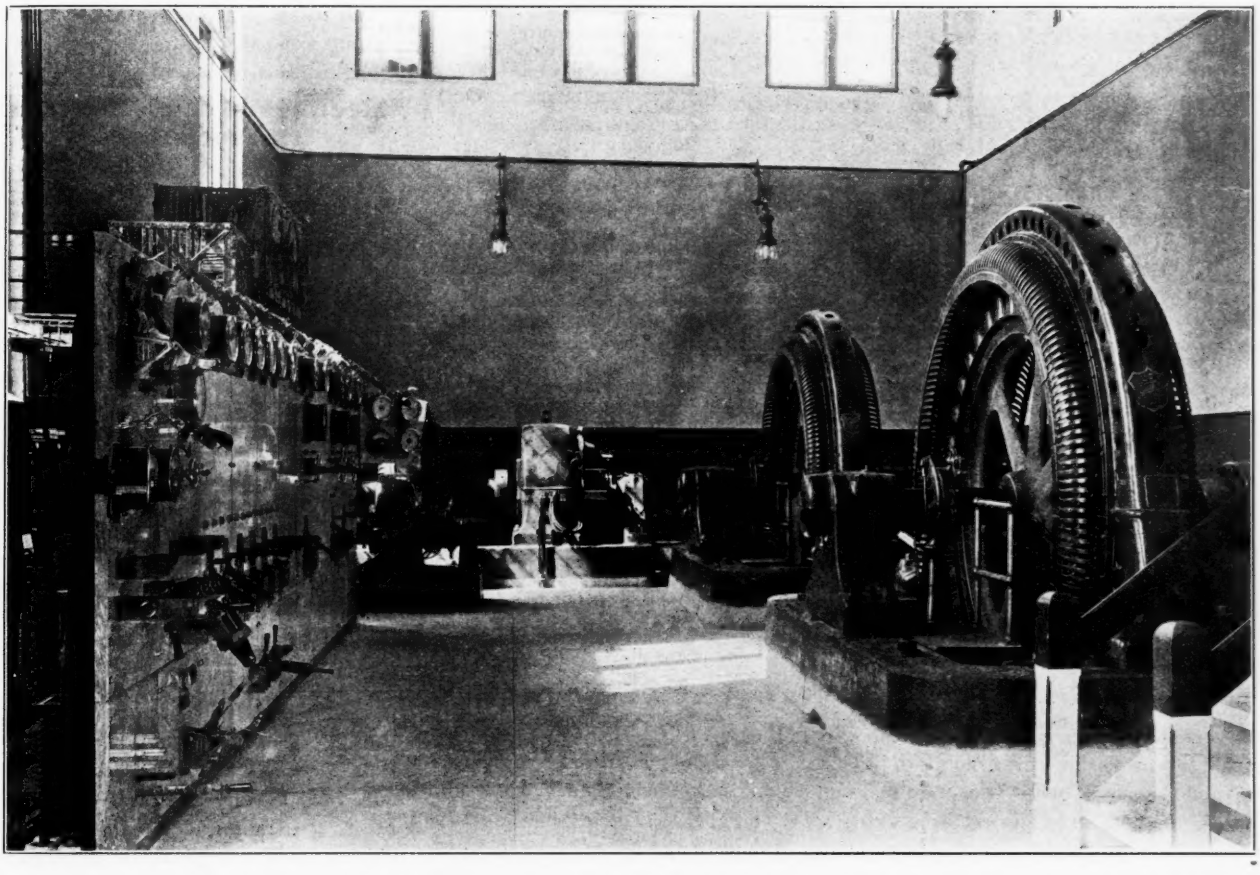
The generating equipment consists of three 600-kilowatt, three-phase, sixty-cycle, 480-volt, alternating-current, revolving-field generators, each direct-connected to a sextuplex water-wheel operating at a speed of 200 revolutions per minute. The exciting current for these generators is supplied from a seventy-five-kilowatt, 120-volt, direct-current generator, coupled to a single water-wheel, or from a motor-driven exciter of the same capacity. Two motor-generator sets, each consisting of a 250-kilowatt, 240-volt direct-current generator coupled to a 480-volt synchronous motor supply current to the variable-speed motors in the machine room. The alternating system was adopted as being best suited to withstand the rigorous requirements of paper mill work and least liable to give trouble with motors when located in moist places, so common in every mill. The current is distributed through a thirteen-panel blue Vermont marble switchboard, arranged with watt-meters and ammeters so that an accurate log may be kept of the power required by each separate department. Thirteen feeder-circuits carry current to fifty-one constant-speed alternating-current induction motors and to eight variable-speed direct-current motors.

The machine room contains two 154-inch Beloit machines. The variable-speed shaft of each machine is driven by a 250-horse-power variable-speed direct-current motor coupled directly in the centre of the shaft. This motor operates at a speed of from 270 to 540 revolutions per minute, corresponding to a paper speed of from 300 to 600 feet per minute. The entire variation is accomplished by means of resistance in the shunt field of the motor. The field rheostat controlling the speed of the motor has 138 steps, which means a change of approximately two feet per minute in paper speed for each step, which is surely a much finer variation than can be obtained through the medium of any mechanical speed-changing device. It must be borne in mind, too, that the changing of speed is accomplished without any loss of time whatever, as the controller is located on the machine-room floor, about midway of the drying rolls, and the move-

ment of the controller handle is but the work of a second for the machine tender. The rewinder at the head of each machine is also driven by a variable-speed thirty-horse-power direct-current motor, having a speed range of two to one. Two seven-and-one-half-horse-power motors of the same type, with twenty-five per cent speed variation, operate the shakers of the two machines. The only other direct-current motors in the mill are two of five horse-power capacity, with a speed range of two to one, which drive special cutters located in the machine-room basement.

The beater room contains six beaters and two Majestic-Jordan engines. The beaters are driven in pairs, one right and one left, by three 100-horse-power motors located in the basement. These motors have their shafts extended both ways with pulleys on either end; outboard bearings are also provided to insure rigidity and freedom from belt slippage. Belts connect the motors directly with the beater pulleys. The drive for the Jordans is one of the most noteworthy in the mill. Each Jordan is directly coupled to a 150-horse-power motor operating at 312 revolutions per minute. The base of the Jordan is extended to receive the motor, which is arranged to slide on rollers as the plug is moved in or out by means of the regulation hand-wheel. In the beater-room basement are located the stock pumps for supplying the Jordans, each driven by a seven-and-one-half-horse-power geared motor, and also the Jordan chest agitators, driven by two fifteen-horse-power belted motors. The controllers for starting and stopping all motors governing the supply of pulp to the beaters and Jordans are located on the beater-room floor, so as to facilitate rapid handling of stock.

In the pump room are located the pumps controlling the water supply and those for handling the ground wood pulp. The entire water of the mill, outside of the boiler feed, is obtained through three six-inch centrifugal pumps, each direct connected to a forty-horse-power motor. An underwriter's pump is used for fire purposes only. Two centrifugal pumps for pumping pulp from the grinders to the flat screens in wet-machine rooms are located in a pit beneath the pump room. Each of these is direct connected to a fifty-horse-power motor. In this room are also the centrifugal Decker chest pump, direct coupled to a forty-horse-power motor; the triplex pressure pump for grinders, driven by a forty-horse-power geared motor; the triplex back-off pressure pump, driven by a seven-and-one-half-horse-power geared motor, and the silver screen, driven by a five-horse-power back-geared motor.



WATAB PULP AND PAPER COMPANY—POWER-HOUSE, CONTAINING TWO 600-KILOWATT, ALTERNATING-CURRENT GENERATORS, ONE 250-KILOWATT MOTOR-GENERATOR SET, ONE 75-KILOWATT EXCITER SET AND ONE 75-KILOWATT EXCITER DIRECT-COUPLED TO WATER-WHEEL.

The group at the wet end of each machine, in addition to the shake, consists of a save-all driven by a five-horse-power back-geared induction motor, suction pump driven by a thirty-horse-power geared induction motor, fan pump with a forty-horse-power direct-coupled motor, machine pump with a seven-and-one-half-horse-power geared motor and machine-chest agitator and flat screens driven by a thirty-horse-power belted motor. To this group belong also the broke beater, driven by a forty-horse-power belted motor, and the broke-beater pump, driven by a forty-horse-power direct-coupled motor.

The wet-machine room contains five wet machines, two deckers and twelve flat screens. The wet machines are each driven by a ten-horse-power back-geared motor. The flat screens, which are located immediately back of the wet machines, are driven through friction clutches connect-

ed to a line shaft by means of a mitre gear, this line shaft being direct coupled to a 100-horse-power motor. The deckers are driven by belt from the wet-machine shaft. A machine shop adjacent to the wet-machine room is driven by a ten-horse-power belted motor.

The wood-room equipment consists of six barkers and a sixty-inch log saw with the necessary conveyor. The logs used for making pulp are taken from the river to the saw by a log haul which is driven by a five-horse-power back-geared motor. The saw and live rolls are direct coupled to a thirty-horse-power motor, the coupling being of sufficient weight to act as a fly-wheel and thus reduce the actual power required for sawing. The sawed wood is carried to the barkers by a conveyer driven by a ten-horse-power back-geared motor; this same motor also drives a splitter. The barkers are each driven by a seven-and-one-half-horse-power direct-coupled motor, the iron base of the barker being cast with a pedestal to receive the motor. The prepared wood is carried to the grinding room by a conveyer driven by another ten-horse-power back-geared motor. A shaving fan, driven by a forty-horse-power belted motor, blows the chips from the barkers directly on to the boiler grates. What additional coal fuel is required is carried in hoppers above the boilers. A ten-horse-power back-geared motor drives a bucket elevator which fills the hoppers directly from the cars in which the coal is shipped.

The Watab Mill has now been in continuous operation for nearly one year. It began making paper a few hours after current was first turned on, and has not been shut down since due to failure of equipment—a most unusual performance for a mill of this size. The complete electrical installation was furnished by the Allis-Chalmers Company, of Milwaukee, Wis., and the design and specifications were prepared by the company's engineers, acting in conjunction with the mill superintendent and Samuel Holmes, paper-mill expert and engineer. The officers of this mill are justly proud of their property and are ready and willing at all times to answer inquiries from interested parties pertaining to the mill and its equipment.

SCHEDULE OF APPARATUS IN WATAB MILL.

Department.	Number.	Motors. Horse-Power.	Type.	Machine-Driven.
Wood room	1	5	Induction	Log haul
"	1	10	"	Conveyer and splitter
"	1	10	"	Prepared-wood conveyer
"	1	30	"	Log saw and live rolls
"	6	7.5	"	Barkers
"	1	40	"	Shaving fan
Boiler house	1	10	"	Coal conveyer
Pump room	2	50	"	Pulp pumps
"	1	40	"	Decker pumps
"	1	40	"	Pressure pump on grinders
"	1	7.5	"	Back-off pressure pump on grinders
"	3	40	"	Water pumps
"	1	5	"	Sliver screen
Wet-machine room	5	10	"	Wet machines
"	1	100	"	Flat screens and deckers
Machine shop	1	10	"	Lathes, planers, etc.
Power-house	2	350	Synchronous	Direct-current generators
"	1	115	Induction	Direct-current exciter
Beater room	1	150	"	Jordan engines
"	3	100	"	Beaters
"	3	7.5	"	Stock pumps
"	2	15	"	Stock chest agitators
Machine room	2	250	Direct-current, variable-speed	Variable-speed shaft of machine
"	2	35	"	Rewinders
"	2	7.5	"	Shakes
"	2	30	Induction	Suction pumps
"	2	40	"	Fan pump
"	2	40	"	Broke beaters
"	2	40	"	Broke-beater pumps
"	2	7.5	"	Machine pumps
"	2	30	"	Agitator and screen
"	2	5	"	Save-all
Finishing room	2	5	Direct-current, variable-speed	Rewinders

The Western Electric Company.

The annual report of the Western Electric Company, Chicago, Ill., states that the sales for the year 1907 were $52,724,168, a decrease of 23.9 per cent. Sales to the telephone companies during the last six months of 1907 were about one-third of those during the same period of 1906. The company's other business in this country and its foreign business were of great volume and made about the same rate of profit as in previous years. The December payroll, 16,259 people, was a decrease of forty per cent.

The New High-Efficiency Lamp and the Topeka Edison Central Station.

The problem confronting central stations as to the basis upon which to dispose of the new high-efficiency incandescent lamps to users has been handled by the Topeka Edison Company, of Topeka, Kan., as follows: Instead of selling tungsten lamps to users or raising their rates for supply, the company will rent these lamps at two cents per day, exchanging them as they burn out.

This is believed to be the first company to use this method, and the results will be watched with great interest by the other lighting companies.

Meetings of Iowa Electrical Associations.

The annual meeting of the Iowa Electrical Association will be held at Des Moines, Iowa, April 22 and 23, at the Savery Hotel. W. N. Keiser, chief electrician of the Des Moines Edison Light Company, is president of the association, and promises a display at the Savery that will show to advantage the great possibilities of electricity.

Immediately following the meeting of the electrical association the annual meeting of the Iowa Street and Interurban Railway Association will be held at the Savery.

Celebrating Edison's Birthday.

A dinner in celebration of the sixty-first birthday of Thomas A. Edison was held by the heads of the departments in Mr. Edison's laboratory, at the Kuger Auditorium, Newark, N. J., on February 11.

It is stated that the legal troubles between Mr. Edison and various moving-picture machine manufacturers have been settled by the formation in Buffalo, N. Y., of an $8,000,000 combination to control the entire moving-picture business of the world. Mr. Edison is to receive a royalty of $200,000 a year.

Nebraska Electrical Trades Association.

The Nebraska Electrical Trades Association has been formed with the following officers: President, E. J. Sullivan; vice-president, George Johnson; secretary, W. L. Burgess; treasurer, J. R. Lehmer.

The first electrical show under the auspices of this association will be held in the Auditorium, Omaha, Neb., during the second week in April.

Electricity in Peru.

Special Agent Charles M. Pepper writes from Lima, Peru, concerning the use of electricity in that country, which offers unusual advantages for its development for power purposes. He says:

Electrical development in Peru is likely to call for increased purchases of material, notwithstanding the fairly large installations that have been made during the last two years. Hydraulic and electrical engineers the world over are familiar with the power that the Andes waters hold in reserve, but not all of them have kept pace with the recent application of this power and with the prospects for its further utilization. Some of the grander projects will have to wait a further period of industrial growth on the part of the west coast before they can become commercially feasible. Such is the proposed tapping of Lake Titicaca, by means of a tunnel through the crest of the Cordilleras, bringing 500,000 horsepower down to the Pacific. This vast volume of power can not be utilized profitably for many years, though some day it will be done.

Other large projects, particularly in relation to railway traction, manufacturing and mining, are not so remote. The waters of the Peruvian Andes present ideal conditions for transformation into electrical energy in their freedom from ice, brushwood, leaves, etc., and these advantages are fully recognized in all the plans that are formulated. Peru now imports coal to the value of $1,000,000 annually, and it is estimated that fifty per cent of this amount could be saved in fuel by the use of water through electrical energy. When the Peruvian coal mines are opened up by getting railways to them there will still be economy in water power.

The Central or Oroya Railway, running from Callao, and piercing the wall of the Andes in the Galera tunnel at an elevation of 15,665 feet, with four per cent grades and numerous zigzags and switchbacks, offers the best opportunity for the application of electrical power for traction on a large scale. This railway, the main sections of which were built by Henry Meiggs in the early seventies, is still, both in its engineering features and in its scenic grandeur, the most remarkable railroad in the world. Naturally its transformation into an electric line appeals to the ambition of electrical engineers, some of whom have made careful studies at their own expense and prepared elaborate plans. The ampleness of the water power in the heights of the Andes is easily determined, but other questions requiring the judgment of experienced railway men, both in regard to engineering and to the relative economy of steam and electric power in handling traffic, have been carefully tested and with a favorable judgment. Some sections of the line present exceptionally favorable conditions for the economical operation of the road by electricity.

When the group of American capitalists who control the Cerro de Pasco mines offered to lease the Central Railway from the Peruvian Corporation, their plans contemplated the immediate electrification of the system and estimates had been made for that purpose. The offer was not accepted and the line will continue to be operated by the Peruvian Corporation. I am informed that the project of changing the motive power to electricity has not been rejected nor yet has it been definitely determined. It is under consideration in the expert technical examination of the property that is now being carried on with a view to obtaining the funds for the physical rehabilitation of the system that is necessary in order to provide for the increased traffic. Financial reasons may prevent an early change to electricity, yet it is the opinion of those who have given careful attention to the subject that within a few years the change will be made and that the economy of electrical power will be demonstrated.

Possibly before the Central Railway is operated by electrical traction the mining industry will undergo a radical modification. Electrical smelting is by many experts thought to be on the eve of introduction. The water power is as abundant for it as for railway purposes. The Cerro de Pasco Company recently completed extensive investigations of the power which may be obtained in the regions tributary to its properties and the results are reported to be satisfactory. Within thirty-six miles of the smelter an available 15,000 horse-power has been located, while at a distance of fifty-five miles and an elevation of 10,000 feet there is 25,000 horse-power. The transmission is said to present no serious difficulties, and when detailed estimates of cost are completed it is possible that definite steps will be taken for the installation of a great electrical power plant.

At Rio Blanco, eighty miles from Lima, on the Central Railway, the Boston capitalists who are erecting a big smelting plant in order to take care of the ore in the neighboring districts have about 3,000 horse-power available and are installing machinery for utilizing 400 horse-power when the smelter begins operations in April. The most successful mining installation up to the present time is reported to be that of the Inca Company, in the Santo Domingo gold fields of Southern Peru. An electric plant of 400 horse-power, which was brought out and set up at some distance from the mine, where there was sufficient water power, is said to be giving good results in working the ores on a larger and cheaper scale. In the department of Ancachs, which is the chief mining province of the country, some installations of small electric-power plants are in prospect and this is regarded as a promising field. The lack of railway and other means of transportation renders freights expensive, but this is no more burdensome for electrical machinery than for other kinds of mining machinery, and the saving to be effected in working the mines justifies the expense.

The future of the trolley tramways has definite bounds, since Peru has only a small number of cities where street-car systems are required, and most of these are already provided with trolleys or have contracted for them. Lima and Callao made the change from horse cars some years ago and their local systems and the lines joining them are electric lines. One steam railway between Lima and Callao, which is controlled by the local trust or Associated Electrical Companies, will have its motive power changed from steam to electricity and be used for freight. The largest extension is of the lines between Lima and the residence suburbs and bathing beaches on the seashore, the most important of which is Chorrillos. A parallel and competing line between Lima and Chorrillos, which depends on steam instead of on water power for its motive force, was built and is operated with very unsatisfactory results to the stockholders, though recent extensions are said to improve the outlook for reducing the deficit. Ancon, a seaside resort thirty miles from Lima, which has also the facilities of a commercial port, may have the steam railway replaced by the trolley. In the towns of Trujillo and Chiclayo, in Northern Peru, existing electric systems are being extended, while the trolley may also be introduced in Paita and Piura, but for many other towns the single mule tramway supplies all the necessary facilities for passenger traffic. At Arequipa, in South-

ern Peru, an extension of the use of electric power is under way.

A few municipalities are not yet provided with electric lighting, but most of those have made provision for its introduction. Growth in the use of electric lights for private purposes in Lima and the other large towns is noted, and the companies engaged in supplying them find an increasingly profitable business.

Some of the larger sugar plantations have their own dynamos and small electric plants for lighting and other purposes, but these are not universal and the representatives of the various companies have still an open field. Efforts have been made to secure the introduction of electricity on the larger plantations to replace steam plowing, and convincing arguments have been made of the greater economy, but so far without much success. Even the most progressive of the planters are conservative on this point and stay by the English steam plow, which has been in use for a generation.

The minor applications of electricity, such as to domestic uses in cooking, etc., have been introduced in Lima with passably encouraging results. An electric cooking stove has had some sales at the hands of a persistent dealer. The high price of coal renders its use economical. Telegraphic and telephone apparatus have a good market, since these systems are regularly being extended. The government follows a definite plan in extending the telegraph lines. The local Italian hospital obtained its electrical appliances in the United States.

The leading electrical enterprise in Peru at the present time is that known as the Trust, or the Associated Electrical Companies. This association supplies the power for all but one of the tramway systems of Lima and Callao, the electric lighting and a variety of industrial purposes. The total available force is to be 17,000 horse-power, consisting of a central installation at Yanacato of 8,000 horse-power, of which 5,000 horse-power is in two machines and 3,000 horse-power in a third machine to be installed—5,000 at Chosica, 800 at Santa Rosa, 400 at Piedra Liza—and 2,500 steam power in reserve. The consumption in 1907 was 7,400 horse-power for force and 3,300 for lighting. The Rimac River and its affluents are the source of these combined installations. Two miles from Chosica, which is thirty miles from Lima, a cement dam, headgates and canal were built to divert the waters of a stream called the Santa Eulalia to the Rimac at a point about two-thirds of a mile higher. At this point a concrete dam and gates are located, which divert the waters of both rivers into a canal a mile and a quarter long. The canal has a grade of one and one-half per cent. From the reservoir two steel pipes, of one and one-half metres diameter each and 670 metres long, lead to the station. The effective head is forty-seven metres. Here five double-nozzle, double-wheel turbines of the Pelton type, direct-connected to General Electric revolving-field three-phase generators, produce 4,000 horse-power. The velocity of the water as it strikes the wheel is 1,800 metres per minute. From the switchboard the voltage is raised to 35,000 volts and transmitted to Lima over a double set of transmission lines. At the chief station in Lima this high-voltage is reduced to 2,300 for distribution.

Just below the bridge at Chosica a third dam has been built, and the river is again taken for the third station at Chacra Sana, farther down the river. At the side of the dam three gates, having their tops level with the crest of the dam, lead the water to the canal. In the dam, just below the entrance gates to the canal, is located an all-steel gate, having its bottom two feet below the canal gates. This is to remove the immense quantities of sand and rocks that the river carries during high water. In three other places along the canal are located settling chambers and waste gates, to remove automatically the sand and gravel. This canal is three miles long, one and one-quarter miles being in earth and the remainder having cement walls and floors. The gradient is three feet per 1,000.

From the reservoir a steel pipe-line six feet in diameter and 400 metres long carries the water to the station. The effective fall is seventy-nine metres. At this station larger units are located, each of 2,500 horse-power, two of which are in operation, the third of 3,000 horse-power, which will be installed, giving a total capacity for the station of 8,000 horse-power and 12,000 horse-power for the two hydroelectric stations. These two stations operate in parallel, or in synchronism with the Lima generating stations. The Chacra Sana station is constructed of solid concrete with concrete-block trimmings for the doors and windows, and steel roof, entirely fireproof. It is ten by forty-eight metres. From the transformer room fifty-foot steel towers carry the transmission lines.

The Lima receiving and generating station has two 750-horse-power water wheels that operate under a head of twenty-four metres. A reservoir and steel pipe-line, the same size as the Chosica No. 1 station, has an automatic relief pipe, seventy feet high and five feet diameter, that takes care of any sudden closing of the turbines, thus relieving the pipe-line and wheels of dangerous strains. The steam section consists of seven engines and boilers with an aggregate capacity of 3,000 horse-power.

From the general station at Lima all public and private circuits, power circuits and railroad circuits are controlled by a switchboard with automatic switches. For the public street lighting, ten circuits supply current to 400 of the latest type enclosed arcs and 1,200 series incandescent lamps for the streets of Lima. The private lighting service for Lima, Callao and other towns is all supplied from the principal distributing station at Santa Rosa, Lima. Over 60,000 incandescent lamps are connected.

The Trust, or Associated Companies, is controlled by Lima capital, but the machinery is from the United States and the installation was made under the direction of American engineers. All the leading electrical companies of the United States have supplied machinery for the various installations in Peru, and their representatives have supervised most of the work. The chief German company, whose head offices are in Berlin, is an active competitor through its local representatives, and it has furnished the installation for the tramway system that does not have water power, for some municipal lighting and traction plants, and industrial plants including mines, a cartridge factory and elevators. A Belgian company, with headquarters at Liege, maintains a local agency.

The prospective application of electricity on a large scale, such as for the Central Railway and for the Cerro de Pasco mines and smelter I have described, but there seems to be a more immediate application for light manufacturing. About 2,000 horse-power on five power circuits is now furnished by the Trust to the cotton mills, flour mills, biscuit, chocolate and cigar factories of Lima and vicinity. Coal is expensive fuel for the local industries, and it has been demonstrated that with the water power which is available electric force can be furnished cheaper.

Most of the electric companies have their own agents and representatives in Peru and no suggestions therefore are necessary as to the means for reaching this market. The point on which I would lay stress is that electricity in all its forms will play a continually growing part in the industrial development on which Peru has entered, and the local conditions are such as to assure that the present world-wide monetary stringency will not seriously interrupt this development. Many enterprises are at the stage where they can be carried forward profitably by the utilization of electricity, while to stop means loss. The industrial impulse in Peru is in reality too strong to be checked.

Illuminating Engineering Society.

A meeting of the New York section of the Illuminating Engineering Society was held at the Engineering Societies Building, 33 West Thirty-ninth street, New York city, on Thursday evening, February 13. At this meeting the new chairman, W. W. Freeman, assumed the duties of his office and called upon the local secretary, P. S. Millar, for a report. Mr. Millar said that the board of examiners of the section had been organized, as had also the Papers Committee. The latter had arranged for two papers. The first is to be delivered at the March meeting of the section, by E. L. Elliott, the title being "The Relation of Architectural Principles to Illuminating Engineering Practice from the Viewpoint of an Engineer." At the April meeting of the section Dr. E. L. Nichols, of Cornell University, will present a paper on "Daylight and Artificial Light."

The chairman then called upon George Leland Hunter to present the paper of the evening, the title of which was "Light and Color in Decoration." Mr. Hunter first differentiated between the method of treatment of illuminating problems which is taken by the engineer and that by the decorator. The former's work is quantitative; the latter's, qualitative.

"It is a great pity that the word 'decorative' is so generally misunderstood. From remarks made before this society one might infer that decoration is synonomous with ornamentation and that decorative lighting means the employment of highly wrought chandeliers and fixtures. Nothing could be farther from the truth.

"Decorative lighting is illumination that is æsthetically satisfactory—the light being so distributed as to avoid violent contrasts of light and shadow, while displaying objects in a manner agreeable to the eye. Lighting to be decorative must be efficient; but it must be more than that. It must be in good taste. The ignoramus is no more a judge of good lighting than he is of a good painting.

"In the last quarter of the nineteenth century the electric light was developed to a point where it is possible to light interiors brilliantly, conveniently, safely, and decoratively. In actual practice, however, the possible has seldom been accomplished. The art is still too new and the tools are still too unfamiliar. And progress has been hindered by adages that merely through repetition have come to have authority.

"Especially is this true in color. Some ignoramus once asserted that warm colors should be used in rooms with north light, cool colors in rooms with south light. Sounds plausible, doesn't it? Warm colors to warm up the cold rooms, cool colors to keep the south rooms from being distressingly hot. What are the facts?

"The facts are that for north rooms blue and green are exceedingly agreeable, while reds are disagreeable. The opposite is true in south rooms. Yellow is cheerful in both. North light coming from the sky is bluish, while south light ranges on a bright day from red through yellow to white and back again as the sun sinks in the heavens. In north light, reds look muddy; in south light, blues are apt to be cold.

"This brings us to a law that is grotesquely violated in general practice as well as in the advice given to their anxious readers by the cosy-corner editors of the how-to-do-it-yourself-magazines: In illumination avoid strong color contrasts. A pretentious café in this city has walls in dark-red burlap, with wall lamps carrying green shades. The proprietor explained to me that the green of the shades was intended to counteract the redness of the walls. Of course, the result was awful—blotches of pink where the unshaded light struck the burlap, with dark and muddy redness elsewhere. If the shades had been red the redness of the walls would have been diminished instead of being accentuated. The effect of the green shades was to cut off the red light that alone could render service on a red background.

"Yellow shades would also have been possible, because yellow is the color easiest for the eye to handle. It comes in the middle of the spectrum, and has a wave length that all eyes can easily apprehend. The colors at the ends of the spectrum are more difficult. Some eyes are better for the long wave-lengths of red, others for the short wave-lengths of blue light. The result of my personal observations is confirmed by the work of different individuals on the photometer. Some have eyes more sensitive to reds, others have eyes more sensitive to blues. Apparently there is a color range of the eye just as there is a pitch range of the voice.

"As in natural light, so in artificial light, color is vitally significant. But we must include not only hues like red and yellow and blue, but also the tints and shades of gray ranging from white to black. They are vastly the more important for revealing the form and relative position of objects. For with them stronger contrasts can be obtained. They traverse the whole distance from white to black, from light to darkness, while the hues make only part of the trip, and weakly. In illustration, white and black without hue are tremendously effective; but the hues, ungrayed, are speechless.

"There has been much written and printed about advancing and receding colors, uselessly. Whether colors advance or recede depends on the situation in which they find themselves. Against a dark background, as at night, lights and light colors advance. Against a light background, dark colors advance. Tints and shades push each other violently apart. Black type stands out against a white page; and so does white type against a background of black paper, which, in turn, would stand out from a white wall.

"The different hues also repel one another. Red pushes away green, and yellow pushes away blue, while red and blue are still more active against each other. But they can be easily reconciled and there are no hues that by the use of a dominant color can not be coaxed into propinquity.

"Hues all look alike on dark nights. Taking the light out of them—or mixing them with black if they are paints—obliterates distinctions. Mixing white with them does the same. Red and green when pure, as in the spectrum, or when nearly pure, as in some pigments, are bitter enemies. But pinks and gray-green dwell together in peace and harmony. Yellow is a most satisfactory dominant on account of its cheerfulness. The most wintry landscape seen through yellow glasses grows warm. Blue glasses produce the opposite effect. Even autumn foliage loses its warmth when viewed through them.

"Mass is the result of color contrast. The shadow on the side of the tree away from the light, contrasting with the brightness of the near side, gives the true solidity. Against a background of blue sky, green fields and forests stand forth; and against them appear the soldiers in red, forced into the foreground by contrast.

"To eliminate light and shade is to eliminate mass and to make solid things look silhouetted. To introduce hue and shade on a flat surface at once simulates the massiveness of actuality. The degrees of contrast are regulated by the amount of opposition necessary to round out shapes and separate foreground from background.

"It is the task of the decorator to confirm what is good and correct what is bad in the work of the architect. If the windows are too high and narrow, the defect must be overcome with draperies. If the room is too wide and low, he must raise the ceiling and bring down the walls. He is like a painter who with the colors from

his palette must follow more or less closely the outline drawing of another.

"In the decoration of interiors hue is important, but light and shade are more important. All should be used discreetly and in moderation. Violent contrasts are dangerous.

"If the ceiling is the right height for the large rooms on a floor, it is too lofty for the small rooms. How shall we lower it?

"Light walls recede and dark walls advance. Keep the ceiling and floor dark and the side walls bright. The ceiling and floor will at once approach each other, while the side walls will open out.

"If a room is too wide and low, give it the opposite treatment. Light the ceiling brightly, and the side walls dimly, and the floor less than usual. But do not overdo the contrasts, and remember that the floor should always be comparatively dark in order that it may seem solid beneath the foot. People slip on parquet floors because the surface looks insecure, rather than because of its slipperiness. The darker its colors and the more intricate the pattern, the more solid will it seem. Rugs are a good floor covering because the pile absorbs so much of the light that they look opaque.

"Doors and windows and mirrors are everything to a room. They open up the walls in which they occur, and the apparent expansion is proportionate to their size. For this reason a low room should have them small, and a high room should have them large. Take the connecting front and back parlors so common in New York city. The windows at the front and the wide doorway at the back tend to exaggerate the awful length. They must therefore be heavily draped in dark colors with plenty of embroidery or other small pattern—for small patterns tend to make surfaces advance. The doorways on the side next the hall are a help, and should be kept as free from light-devouring fabrics and patterns as possible. The walls of the room should be hung with paper of large figure, or plain and light color, and large mirrors and pictures should be employed freely. The lamps should be so placed as to light the side walls more brightly than the ends of the room. Chandeliers and hanging fixtures will do this best if the ceiling is high; wall brackets if the ceiling is low.

"I have been trying in vain to understand why so much effort is being exerted to illuminate interiors without wasting light on ceiling or walls or refractors. Is it possible that any one fails to realize that reflecting surfaces and refracting media that make the light useful by changing its make-up and lessening its intensity, are imperative? Can it be that they are serious when they lament the loss of the light that goes to the ceiling? Do they not appreciate that to illuminate a room is the same thing as to light its walls and ceiling and furniture, and that the light thus employed is usefully employed? Or is it possible that they still believe in the virtues of pure white light, and fancy that the object of a lamp is to send light directly to the eye?

"The light that reaches the eye directly is not of the slightest use. You do want to see the flame, you want to see the room and the people in it. Besides, the light hurts the eye, even when reflected from a mirror, and is agreeable only when its intensity has been lessened by reflection from some surface, or refraction through some material that eats up part of it. The reflected light is less in quantity, having lost some of its colors, but the colors that remain are those that identify the thing seen, and make it visible.

"Here comes up the question of the color of walls and ceiling. If they were in black velvet, they could not assist us in the illumination of the room. But if they are in ivory—not white, that is disagreeable to the eye even in the weaker form that we get in reflection from plaster—they will not only distribute the light agreeably and economically, but will themselves be cheerfully visible—which would seem to be desirable.

"A small room of good proportions with light walls and ceiling is beautifully illuminated by two sixteen-candle-power bulbs suspended from the centre of the ceiling about six feet six inches from the floor. In large rooms the light of lamps as low as that would strike the eye unpleasantly, especially as their power would of course be greater. Only in rooms with high ceiling where the lamps can be hung high is the use of powerful units permissible.

"The candle-power of the light source is directly regulated by the height of the ceiling. The light that blinds the eye at three feet is harmless at nine, having lost eight-ninths of its intensity. In a huge auditorium like that of Madison Square Garden lamps of enormous power can be effectively used. In interiors with low ceiling the units must be kept small.

"Another way of preparing light for the eye is to refract it through frosted or opal or mosaic glass, or through crystal beads or prisms. This turns the lamp from something to be avoided into something that the eye likes to look at, and at the same time it transforms glare into diffused light. The refractors play the same part as ceiling and walls, and would help to illuminate even a room in black velvet. The use-efficiency of a lamp that distributes light can not be compared on the basis of photometric tests. The light that counts is the light that is actually employed in the revealing of objects to human vision. And I may suggest that for general illumination, three feet, so often employed in photometric tests, is lower than the plane of greatest usefulness for general illumination.

"The color of lamp shades and refractors is highly important. Those in golden yellows, ambers and light browns are safe almost anywhere. In a red room, blue or green shades should never be used, nor red shades in a green room. As I have already intimated, rooms finished in dark colors are almost impossible to illuminate brilliantly, and look best when kept comparatively dim. Whether the room be light, or dark, the material of the lamp standards and fixtures should never be dark enough to contrast strongly with the lights. A chandelier in hammered iron in a classic Colonial room is an atrocity.

"The development of color by contrast can easily be illustrated in an interior that has dark mahogany furniture with green upholstery and draperies. Put a red shade on the lamp and the mahogany becomes lighter in tone and less prominent, while the green fabrics become darker in tone and advance toward the eye. Put a green shade on the lamp, the reverse happens and you have to be careful not to stumble into the furniture.

"What makes most Mission furniture so displeasing to persons of fine taste and culture is not so much that it is the negation of style, and lumbers up the house with its waste of wood, as that its dark colors accentuate the unwieldiness and necessitate an environment that it is impossible to light satisfactorily. Let who will cry aloud for darkness in decoration, the illuminating engineer should demand light colors.

"The best that can be done in a room with dark walls and ceiling is to use small units generously distributed and enclosed in globes or crystals that are competent to break up the light and distribute it without mural assistance. To direct all the light to the floor—although this does produce high photometric tests in the plane of illumination—is to apply to general illumination, principles that are properly applicable to local illumination only.

And even in local illumination the light reflected from book or embroidery is much more agreeable if it has been subdued before reaching the object illuminated. The printed page that shines beneath the light reflected down from the white polished surface of a tin desk shade is not lighted efficiently, though invariably lighted too much. A smaller amount of light from an opal globe or frosted bulb is infinitely preferable.

"Illuminating surfaces are a necessity in artificial lighting. They may glow by refracted light or shine by reflected light, but you can no more get along without them than you can pull yourself up by your bootstraps. And the light eaten up by these surfaces is not wasted unless they are opaque or dark in color and exact too high a toll. If they reflected and refracted perfectly, walls and ceiling and floor would be solid mirrors reflecting and re-reflecting unshaded flames; this would be the extreme of economy, but it would not be decorative illumination.

"The light that is eaten up by reflecting and refracting surfaces is not wasted. Its disappearance tones down the luminous whiteness, leaving the light that is not devoured fit to illuminate objects utilized as a reflecting surface."

Mr. Hunter then made a number of experiments to illustrate the points brought out in his paper. By lowering the illumination of the room and then suddenly throwing on the cove lighting, he showed how the cove seemed to move back and the room become more spacious. By suddenly throwing on the ceiling fixtures, which reflect a large part of the light against the ceiling, he showed that this seemed to raise the ceiling and make the room higher. Conversely, by turning off the ceiling fixtures and the cove lighting, the room apparently contracted again.

By a number of samples of wall paper he showed how green light darkens red and orange more than it does green and blue; and conversely, how blue or green light darkens the red end of the spectrum the more. Yellow, on the other hand, affected the various shades of paper less than red and blue.

Mr. Hunter also showed a number of lantern slides illustrating good and poor decoration of rooms. Some of these rooms with low ceilings were paneled in dark wood, which tends to bring the ceiling still lower. Other slides showed rooms with badly arranged mirrors, which made it impossible to avoid glaring effects. Several examples of good illumination and decoration were shown.

The discussion was opened by H. F. Hubert, who said that the arts of illumination and decoration seemed to be just emerging from the dark age. In this country we have been so busy trying to get the work done that we did not give the necessary time and consideration to carrying out the original idea of the architect. Generally, the plans for lighting the building are drawn up and even the contract let before the scheme of decoration is considered, and this often renders it impossible for the lighting expert and the decorator to work harmoniously. The French particularly are more advanced in these methods than we, and the Germans also are giving the subject of decoration the study which it deserves. Mr. Hubert said emphatically that the illuminating expert should be consulted before the contract is given either for the lighting arrangements or for the interior decoration, and in every case the aim should be to carry out the scheme of the architect.

Dr. H. H. Seabrook said that in the study of colors, the Germans are now leading, but they are lacking in taste, and it is to be hoped that their influence would not be controlling in this country. It should be remembered that while a change in intensity may not affect vision it does change color effects. He discussed the two laws—that of the complementary colors and that of simultaneous contrasts. When two complementary colors are placed side by side on a black background and then lighted by one of the two colors, the other, of course, disappears. When, however, they are placed upon a light background, the opposite effect results. When such contrasts occur the central portion of the colored space appears paler than the outer. He said it is a curious fact that light from a kerosene lamp, in which the red so strongly predominates, and from acetylene, in which the blues are powerful, seemed to be better for studying color effects than light from gas and electric lamps, although the latter lie between the other two and nearer the more luminous portion of the spectrum. Dr. Seabrook pointed out the curious fact that his experience shows that those persons who see the beauties of the impressionist's art always have defective eyes; defective not only so far as vision is concerned but even for color. They are usually near-sighted, so that objects naturally appear indefinite, and in mixing their paints, they do not reproduce the colors before them.

E. Y. Porter questioned a statement made by Mr. Hunter, that the injurious effect of an unshaded incandescent body decreases according to the law of inverse squares. While the image upon the retina may be smaller, the intensity is not changed appreciably by changes in distance; therefore unshaded lamps are inexcusable in any room.

Dr. Louis Bell spoke of some of the peculiar effects which he found in his recent study of illumination problems. The colors of paints are easier to deal with than those of papers. The former show diffuse colors, while the latter show selective absorption. Paints change the color somewhat, but in papers the colors are often most bizarre. Pure greens are never found in papers, nor are pure yellows nor reds. Indeed, some of the greens have a distinct amount of red in them, and the reds contain yellow and often blue. These factors are not noticed under daylight, but under artificial light, where the color of the light is different, they become noticeable, and often upset the entire scheme of the decorator. He suggested that decorators might use the spectroscope in studying their colors with great advantage, as this would indicate to them the probability of some unexpected effect being caused when the color of the light was changed from what had been intended.

A. J. Marshall said that a feature of the prismatic shades which seemed to have been overlooked by Mr. Hunter was that they would transmit a certain amount of light through them, allowing this to fall upon the walls and ceilings for general illumination, while they direct the greater part of the light to the point where it is to be used.

Closing the discussion, Mr. Hunter said that the colors of papers are not pure, but it is their mixed quality which gives them their chief attraction. Of course, however, this should be borne in mind when providing the illumination for the room, as otherwise undesired effects will result. The points which Dr. Bell had made against the colors of papers apply equally well to colored glasses. There is an additional effect to that of pure reflection which must be reckoned with. Mr. Hunter did not think that mathematical studies of color are satisfactory, because they do not take into account the intensity of illumination. If yellow and its two neighbors, orange and green, were taken out of the spectrum, it would be impossible to secure a cheerfully lighted room under any conditions. Replying to Mr. Marshall, Mr. Hunter said that he appreciated the value of prismatic shades when properly used, but he deplored their use when unnecessary.

The meeting was then adjourned.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

The Design of Small Transformers for Metallic-Filament Lamps.

A year or so ago the introduction of the high-potential incandescent lamp offered the central station a means of increasing its load without adding more copper to the system. Unfortunately, the recent developments in incandescent lamps have been in the other direction, the lamps being for low voltages, except when in large sizes. The smaller lamps may, however, be employed if the voltage of the system can be lowered. The plan here discussed by F. B. O'Hanlon is the introduction of small transformers, which lower the potential from 200 to 100, or even lower. The author discusses, at some length, the design of transformers of this class. The work is simple, for elaborate stampings are not needed, but it is advisable to use good transformer iron and pure copper wire. The most satisfactory design is the autotransformer, and the most efficient arrangement is that which gives a one-to-one transformation. Three designs are worked out for transformers of the core type, but the author points out that the shell type is equally available and has some advantages over the other, as it is easier to balance the winding magnetically. When this is done a machined joint at the yoke pieces is satisfactory, but it is well to design this so as to have it as large in area as possible. A stock of transformers for various ratios may be assembled with but two or three sizes of core plates and coils.—*Abstracted from the Electrical Review (London), January* 31.

Advantages and Disadvantages of Superheating.

An abstract is given here of an address delivered recently by Michael Longridge before the Manchester (England) Association of Engineers on "The Advantages and Disadvantages of Superheating Steam." The speaker said that the question is almost entirely one of economy, but there are some mechanical disadvantages attached to the use of superheaters. The independently fired type seems to give little mechanical trouble except in repairs. Those of the "down-take" type give a good deal of trouble, due to extra expansion at the higher temperatures; and it is difficult to keep valves and glands tight. The engine pistons are also liable to seize when superheated steam is used, owing to a lack of lubrication. This is sometimes due to the pressure of the water, sometimes to a distortion of the cylinders from unequal expansion. This should be overcome by allowing larger clearance between the piston and the cylinder. The cost of superheating was divided into two parts: The cost of heating the steam and the cost of installing and maintaining the superheating apparatus. It is shown by calculation that nine per cent additional heating is required to obtain a superheat of 200 degrees. To get a steam temperature of 500 to 600 degrees with a superheater of reasonable surface a gas temperature of 1,000 to 1,200 degrees is required. In the case of a Lancashire boiler working at 150 pounds pressure, the superheating can be effected at an expense of five per cent of the total heat entering the boiler. This shows that by properly proportioning the parts of the plant it is possible to get reasonable degrees of superheat at half price. The advantages of superheating are the prevention of wet steam and the waste which this causes when it is deposited on the internal surface of the engine cylinder. Secondly, when a boiler is overworked superheating may at times reduce the demand for steam sufficiently to give the firemen a rest. Another advantage is the opportunity to increase the rate of evaporation at times of temporary overload. References were made to the reports of the French boiler insurance companies which show that a saving of ten per cent in steam is obtained by superheating, and eleven per cent in coal for simple engines, and twenty-three per cent in steam and twenty-one per cent in coal for compound engines. These demonstrate the economic advantage of using superheated steam. The question yet undecided is just how great this advantage may be.—*Abstracted from the Mechanical Engineer (London), February* 1.

Thermoelectric Properties of Common Metals and Their Alloys.

While considering the design of a low-reading potentiometer it became desirable to determine, with some degree of accuracy, the thermoelectric properties of the more common metals; particularly, data were wanted showing the properties of the alloys used in the construction of electrical measuring instruments. To supply this information, which was not obtainable in the scientific treatises, a series of measurements was made by A. G. Warren and F. Murray. The results of these measurements are given here in tabular form, and also in two curve sheets. The method adopted consisted in connecting samples to be tested as a fourth side of a rectangle, the other three sides of which were formed of cast phosphor-bronze rods soldered together. The test sample was soldered to the ends of the phosphor-bronze rods, a galvanometer being inserted to serve as a measuring instrument. The resistance of this circuit was determined before it was completely closed. The two thermo-couples were then inserted in calorimeters containing water, and the various differences in temperature were produced and the deflection read. From this reading and the resistance of the circuit the difference in electromotive force at the two junctions was determined. The results were rather surprising, as it was found that the physical treatment of a sample affected in a marked degree its thermoelectric power. Taking the phosphor-bronze rods as a reference metal, the highest electromotive force for a given difference in temperature directed from the bronze to the material in question at the hot junction was shown by iron; next came steel, and, some distance below, manganin, closely followed by copper. Again, below the copper were three other samples of manganin, these all being samples of wire of different sizes. On the other side of the phosphor-bronze rods were several alloys which showed a difference of potential diverted toward the phosphor bronze at the hot junction. These are, in order of decreasing thermoelectric power, "eureka," platenoid, platinum silver, rolled phosphor-bronze rods, gun metal, soft brass, aluminum, hard brass, lead, solder, phosphor-bronze sheet, and then several sizes of phosphor-bronze wire. As these results show, different specimens of the same material give sensibly different results, depending upon the mechanical treatment to which they have been subjected. By taking a piece of

drawn brass wire, heating it and then quenching it in water, the thermoelectric power was increased about fifty per cent. It is evident from this that the thermoelectric properties of a substance are not determined by the chemical operation alone, as the physical treatment is an important factor.—*Abstracted from the Electrician (London), January* 31.

Instruments and Methods Used in Radiometry.

An excellent study of the instruments and methods used in measuring radial energy is given here by W. W. Coblentz, who describes each method in detail and explains the types of instruments which have given the most satisfactory service. Four instruments are considered: the radiomicrometer, which is a D'Arsonval galvanometer, the moving system of which consists of a small thermoelectric circuit; the linear thermopile; the radiometer, in which a delicately suspended blackened body is deflected by the rays falling upon it; and the bolometer, in which the resistance of an iron arm of a Wheatstone bridge is varied by the heating effect of the radiator falling upon it. This investigation has shown that the radiomicrometer is capable of great improvement by reducing its weight, by lengthening its period, and by placing it in a vacuum. The sensitiveness of this instrument is limited by magnetic conditions, so that it is only a fifth of that of the best bolometer. The thermopile, constructed according to Reuben's design, is as sensitive as the best bolometer, and its heat capacity can be greatly reduced by using thinner wires, which are made shorter to keep the resistance low. The error due to the Peltier effect is about one part in 300. This instrument is not so well adapted for instantaneous measurements as is the bolometer, and it does not admit of so great a range in variation of sensibility, but is very steady and useful for measuring weak sources of radiation such as the extreme ultra-violet and infra-red regions of the spectrum. It is found that the radiometer can be made as sensitive as a bolometer, but then its period is much longer. It is not selective in its action, and hence may be used for measuring ultra-violet radiation. The chief objection to it is its long period, but it is easily sheltered from temperature changes and is not subject to magnetic perturbations. In action it resembles somewhat a photographic plate, in that it will detect weak radiation, provided time be given. On account of its steadiness it is probably the best adapted to search for infra-red fluorescence. A bolometer is difficult to shield from temperature changes, and in spite of its small heat capacity it has a drift due to small and unequal warming of the strips. It is the quickest of the four instruments and the best adapted for registering the energy radiated from a rapidly changing source. The auxiliary galvanometer is the main source of weakness in measuring radiated energy. If a rotating sector disc be used for reducing the intensity of the source, care must be taken to guard against errors which this is likely to introduce.—*Abstracted from the Bulletin of the Bureau of Standards (Washington), January.*

Electricity in the Textile Trade.

The first requirement of the textile manufacturer may be said to be steadiness of drive, for this affects both the quality and the output of his yarn. Uniformity of speed was unattainable until the application of the electric motor, and more particularly of the three-phase motor driven by power supplied from a turbo-alternator. Although the modern mill engine is a very fine machine of its kind, it has the disadvantages of low-speed reciprocating motion, dead centres, want of balance and varying angular velocity. These defects are inherent, and so long as engines are used in textile mills, so long will the machines which they drive suffer from irregularities of speed. At the present time gas engines need hardly be considered, since every defect of the slow-speed reciprocating steam engine is present in the gas engine in a markedly greater degree. Other disadvantages of the steam engine for textile purposes are also discussed here by E. L. Hill, who criticizes it for the space it takes up, both on account of its slow speed and hence its large size, and because of the mechanism used for transmitting the power from the engine to the line shafts. Moreover, the transmission losses are high and increase rapidly as the plant is loaded up, so that the friction and bearings, gear wheels and other transmission losses become very serious items. The variation in angular velocity in the reciprocating engine is chiefly caused by the fewness of the impulses that its pistons receive during each minute. These amount to a few hundreds at the most, while in the turbine these impulses are measured in hundreds of thousands. The turbo-generator has a further advantage, as it can carry continuous overloads for long periods without damage. The best modern practice divides the load in the textile mill between two machines, each of which is capable of withstanding, whenever required, an overload of 100 per cent for ten hours with a slightly higher steam consumption. The turbo-alternator occupies about one-tenth the room of the reciprocating engine, while if the power be divided between two turbines they will not take up more than one-seventh of that which a single engine would require. When alternating currents are employed for driving the machinery, the constancy of the frequency has an all-important effect upon the steadiness of the running. The speed of the motors depends almost entirely on the frequency of the supply and is only affected to a small extent by variations in the voltage of the supply and the load on the motors. Therefore, if the frequency remain constant, the speed of the motors will not vary and will be the maximum that the fabric will permit. With uniform speed fewer ends are broken and no allowance need be made for sudden variations. With a mechanical drive, on account of the irregularity, this maximum speed can not be adopted, as it would be exceeded at times. On account of this steadiness and increase in speed, both the quality and the quantity of the yarn are improved. Of the three ways of driving, the group system is the commonest and usually the most economical, but the individual drive has some distinct advantages and is being used to a considerable extent. It is especially suitable for weaving sheds, where the horse-power of the shafting compared with that of the looms is high, and where a large percentage of the looms is constantly at rest. In a new shed a great saving in the building can be obtained by adopting the individual drive, as no provision need be made for long lines of heavy shafting, and there are incidental advantages due to improved lighting and the absence of overhead pulleys, belts and shafting. For driving looms three-phase motors are now available, rated from one-third to two and one-half horse-power. Group driving is usually the best in spinning mills, because the process of spinning is continuous. Mules should always be driven on the group system, because their frequent reversals call for an amount of power installed far in excess of the average required. The drive should always be arranged so that one motor works several mules. The author states that by the middle of the present year six per cent of the total spindles in Lancashire, England, will be electrically driven.—*Abstracted from Electrical Engineering (London), January* 30.

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

The "American" Flaming Arc Lamp.

The accompanying illustrations give a good idea of the appearance and mechanical details of the "American" flaming arc lamp, which has been placed upon the market by the American Flaming Arc Lamp Company, of Boston, Mass. This lamp has been developed upon the Baker-Bartlett system, and is the result of twelve years' experience in all types of arc-lamp design, including five years' special work upon the development of the flaming arc. The principal feature of the lamp depends upon a new principle of electrode feed and arc control. This principle consists broadly in feeding the carbon electrodes by the fusing or disintegration of a longitudinal feeding strip on the electrode, this strip being composed of a material of lower fusing temperature than that of the electrode itself. This permits the support of the electrode at a point above and away from interference with the arc.

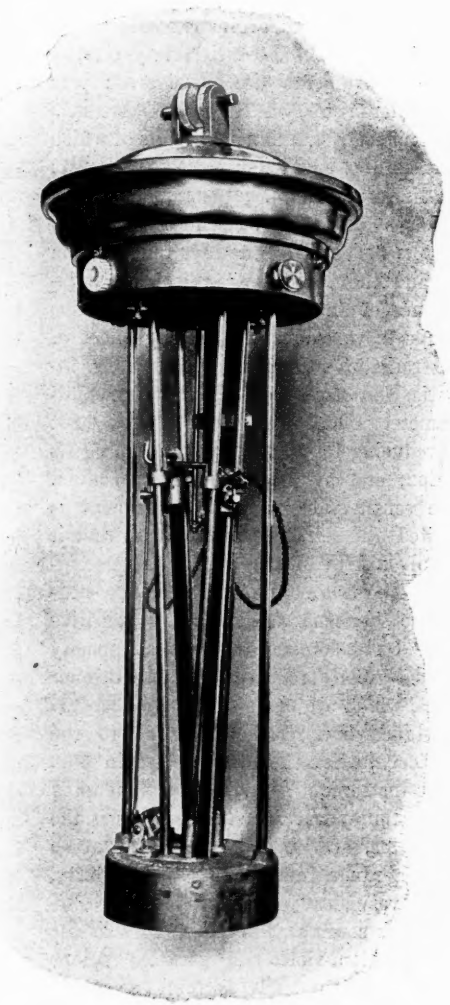
GENERAL VIEW OF THE "AMERICAN" FLAMING ARC LAMP.

As may be seen from the accompanying illustrations, the chemically impregnated electrodes are mounted in holders arranged to permit simultaneous downward feed. One electrode is provided with an external longitudinal projection of aluminum about 0.005 of an inch in thickness and projecting about one-sixteenth of an inch. The lower end of this aluminum projection rests upon a feeding support located about three-quarters of an inch above the arc. During the burning of the lamp the lower end of the aluminum gradually fuses and oxidizes, thus permitting a continuous, uniform downward feed of the electrodes at a rate of about one-sixtieth of an inch per minute. This method of feed and the construction of the lamp maintain a free and unrestricted arc in a fixed position about three-quarters of an inch below the feed support.

The aluminum projection does not introduce any disturbing element detrimental to the arc, and, besides controlling the feed, provides for low electrical conductivity in the electrode and introduces about the same amount of metal as the usual internal conducting wire which it replaces. There is no cohesion or welding between the aluminum projection and the feed support because of the well-known non-cohering qualities of aluminum. Most of the aluminum is vaporized, and the residue is deposited in the form of minute glass-like globules of the fused oxide in the ash-tray at the bottom of the globe.

The arc in this lamp is governed by a novel system of magnetic attraction, in contradistinction to the usual repulsive magnetic field. This attractive magnetic field flattens and spreads out the arc, holding it in a vertical plane and eliminating the necessity of a confining chamber or economizer.

The lamp is started by means of a small series magnet operating, through a rod and angle lever, to separate the carbons. At the end of the trim life a small cutout magnet automatically extinguishes the arc.

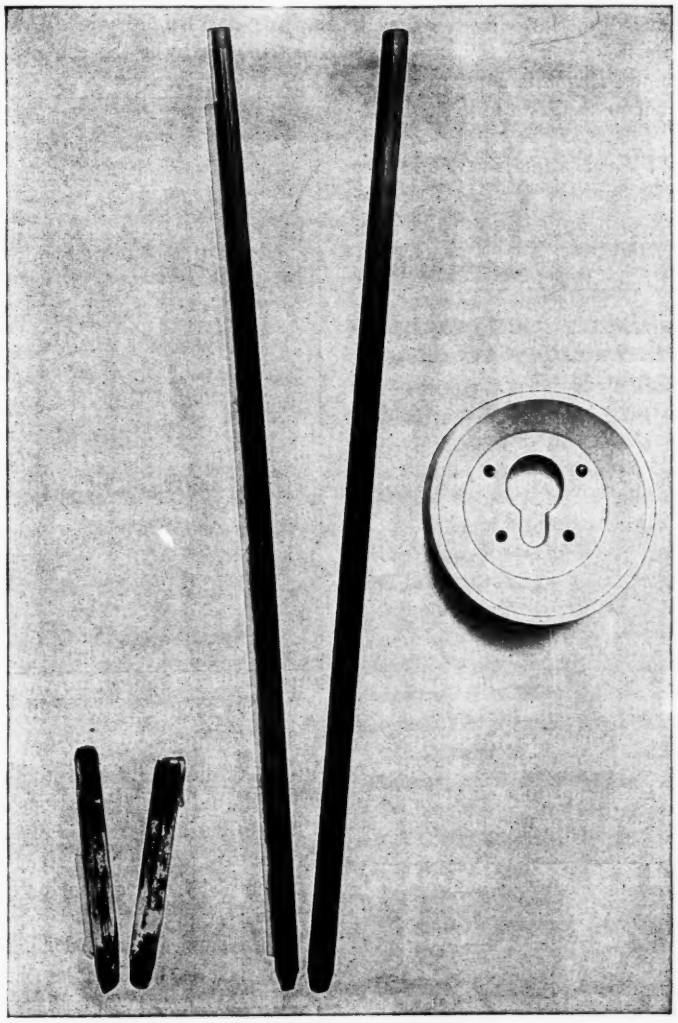


INTERIOR CONSTRUCTION OF THE "AMERICAN" FLAMING ARC LAMP.

This lamp operates at fifty to fifty-five volts on line voltages of 100 to 120 volts, two lamps being placed in series. The lamps may be operated two in series on the usual commercial voltages from 100 to 130 volts, and a corresponding number in series on higher voltages, the same lamp being used for either alternating or direct current. Upon alternating currents the

best results are obtained by burning the lamps in multiple, at an arc voltage of fifty-five volts, through the medium of a small autotransformer.

The trim life of the lamp is about ten hours with fifteen-and-three-quarter-inch carbons. The globe is eleven and one-half inches in diameter, and of a nearly spherical shape. The shell or exterior casing of the lamp is of hard, pure copper, and especial attention has been given to the preparation of a superior design. The mechanical parts of the lamp are made of brass and composition castings, which are nickeled to prevent corroding; the insulation is composed of lava, mica and glass, and the reflector and resistance spool are of porcelain. The magnet wires controlling the arc are embedded in indestructible asbestos cement. The carbons are firmly held by thumb-screws, and the globe is safely wired to the globe collar. The ash-tray is of heavy composition casting.



ELECTRODES BEFOBE AND AFTER BEING USED, AND REFLECTOR OF THE "AMERICAN" FLAMING ARC LAMP.

New General Electric Lamp Factories.

In order to provide for the very heavy demand for Edison lamps, and to take care of the new developments in Gem, tantalum and tungsten lamps, the General Electric Company has in the past year built four new factories at East Boston, Mass.; Toledo, Ohio; Fort Wayne, Ind., and Newark, N. J.

The factory at Toledo is confined to the production of Gem filament lamps only. That of the Newark factory to tungsten lamps only, and the factories at East Boston and Fort Wayne to the regular carbon-filament lamps. In addition the General Electric Company has erected a new factory building at Harrison, N. J., adjoining the present lamp factory, which is devoted to the production of tungsten lamps.

In addition to these new factories the main factory at Harrison, N. J., continues its large output of carbon and Gem filament lamps. The total productive facilities of the General Electric Company now aggregate sixty million lamps per year, so that it is in excellent position to supply all demands from customers.

The "Federal" Couch Bracket.

The accompanying illustration shows a very attractive couch bracket and portable which has been placed on the market by the Federal Electric Company, Lake and Desplaines streets, Chicago, Ill. The standard equipment is furnished in antique brass with a Hubbell standard Edison base pull-chain type of socket, eight feet of green silk cord, with standard Edison base attachment plug, and a specially designed brass half-pear shade finished in the same manner as the balance of the fixture. This fixture is made in the following special combinations: The bracket may be used as a piano, reading lamp, wall, or decorative fixture.

THE "FEDERAL" COUCH BRACKET.

More Westinghouse Locomotives for the New York, New Haven & Hartford Railroad.

The New York, New Haven & Hartford Railroad Company has ordered six additional electric locomotives from the Westinghouse Electric and Manufacturing Company. These locomotives will be of the same general type as the others which have been provided for the operation of the electrified division of the New Haven road.

Mexican Light and Power Company.

The annual report of the Mexican Light and Power Company for the year ended December 31, 1907, shows actual net earnings in United States currency of $1,490,114, as against $1,075,286 in 1906.

Trains Under the Hudson River.

An inspection trip of the upper McAdoo tunnel, which passes under the Hudson River between Morton street, New York city, and Hoboken, N. J., was made on the afternoon of Saturday, February 15.

Automatic Air Dust-Removing Devices.

The Sanitary Devices Manufacturing Company has introduced an excellent system for the automatic removal of dirt and bacilli from buildings. The company's patented devices accomplish this either by compressed-air systems, vacuum systems or a combined system of compressed air and vacuum. These systems are applicable to stationary plants in hotels, offices and other buildings, and portable apparatus for general service.

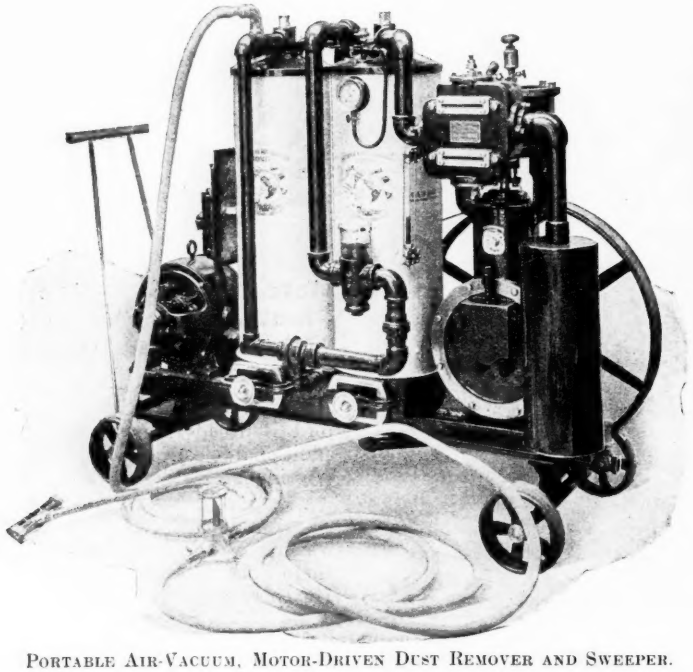
It is an easy matter to pipe either new or old buildings for the utilization of any of these systems, and connections may be made from the risers by means of flexible hose to the dust-removing apparatus, which is operated by an attendant in much the same fashion as a broom or duster.

A twelve-inch vacuum sweeper has a cleaning capacity of 400 yards of carpet per hour or, in actual practice, ten to fifteen large rooms.

The patent vacuum sweeper is constructed on the principle of using vacuum to create atmospheric pressure on the surface to be cleaned. The bottom of the sweeper is separated by a partition, which is depressed one-thirty-second of an inch below the surface. When the sweeper rests upon the carpet the surface proper forms a hood, the partition being one-thirty-second of an inch depressed, and permitting the free passage of air through an inrush slot which is absorbed by the suction slot. The air enters through the inrush slot at great velocity, impinges under pressure on the carpet or floor, loosens the dust and carries it into the vacuum chamber, thence through the hose to the stand-pipe, and into the dust-arresting and containing tanks, which are generally located in the basement.

The accompanying illustration shows a modern house-cleaner in the form of a portable vacuum sweeper for hotels, department stores, theatres, sanitariums, etc. This device is used to clean carpets, furniture and draperies without removal, and is operated by a three-horse-power motor. In utilizing this apparatus it is, of course, not necessary to have the building piped.

Frank W. Wood is the New York sales agent of the Sanitary Devices Manufacturing Company, with offices at 11 East Twenty-fourth street, New York city.

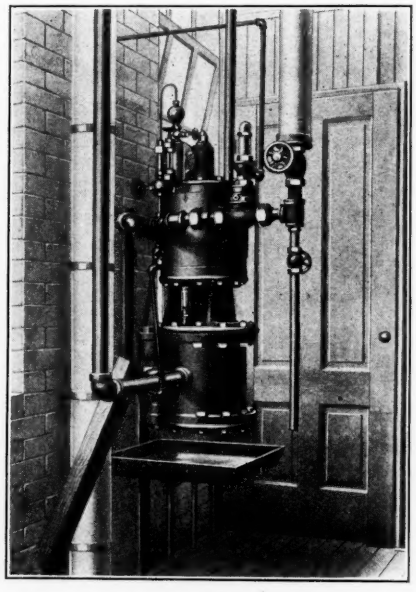


PORTABLE AIR-VACUUM, MOTOR-DRIVEN DUST REMOVER AND SWEEPER.

Westinghouse Air-Compressors in Laundry Works.

Compressed air to-day plays quite as important a part in the laundry as it does in a score of other industries. The Westinghouse Air Brake Company has recently devoted considerable attention to the application of its standard compressors to laundry service, and the installations have invariably been successful.

The illustration shows a typical laundry compressor plant which consists of a nine-and-one-half-inch by eleven-inch by ten-inch compressor with plain air-cylinders, controlled by an S-4 governor, and mounted on the wall so as not to take up any space that could be utilized for another purpose. The boiler pressure is 100 pounds, and the exhaust is used for heating the building and feed-water. The air-inlet is piped through the top of the window. The compressed air is discharged into two reservoirs connected in series. Both high and low-pressure lines are taken from the second reservoir, a B-3 feed-valve controlling the low-pressure line. The pipe-lines, varying from one inch to three-eighths inch, according to the distance from the compressor plant, run along the walls near the floor, and under the floor to the various machines.



WESTINGHOUSE COMPRESSOR IN LAUNDRY WORK.

A two-pressure service is required: very low pressure for gas burners, sprayers and rolls, and higher pressure for dampening presses.

Where hand work is done, employing ironing boards, the irons are heated in a metal box connected to both gas and low-pressure air supply. By properly regulating the admission of gas and air a very hot blue flame, similar to that of the Bunsen burner, is obtained. This method of heating greatly facilitates the process at an appreciable saving in gas. The flame can be adjusted to give any degree of heat desired.

The hollow cylinders of the rolls and mangles are heated in a similar manner. Air for this purpose is used at three or four pounds pressure. Dampening presses are operated by air at higher pressure.

Where individual electric drive is used, as is the practice in the more modern laundries, the high-pressure air supply is

used for cleaning out the motors as well as the rest of the machinery. Air is also used for blowing whistles, and in the boilers as a smoke consumer. For this purpose it is injected by jets into the smoke over the top of the fire. The air and fine particles of coal form a combustible mixture, which burns far into the tubes, causing less deposit in them. It increases the steaming power of the boiler and allows the temperature of the fire box to be lower for the same boiler performance and fuel consumption, besides almost entirely eliminating the smoke.

The records of one laundry show for an increase in business of twenty per cent since the compressor was installed, about a year ago, a reduction in gas bills of twenty per cent, making a saving of thirty-three and one-third per cent in gas consumption effected by the use of compressed air.

The Toronto Electric Light Company, Limited.

At the twenty-fourth annual meeting of the shareholders of the Toronto Electric Light Company, Limited, held at the head office of the company, in Toronto, Ontario, February 11, the report of the directors for the year ended December 31 showed an income of $1,039,716.42. The expenses, including interest on debentures, amounted to $651,925.57, leaving a balance to profit of $387,790.85. Out of this there have been paid four quarterly dividends at the rate of eight per cent per annum, amounting to $245,503.39, leaving a balance of $142,287.46 to be carried forward to profit and loss, bringing that credit up to $160,344.89. During the year a large proportion of the change has been made from the steam plant to power apparatus driven by Niagara Falls. As both systems have been more or less used in operating, the percentage of expenses to gross receipts has been somewhat larger than would otherwise have been the case.

For Electrical Licenses in Ohio.

On February 6 A. C. Masters, of Columbus, Ohio, president, and M. W. Hansen, of Toledo, national director, of the National Electrical Contractors' Association, appeared before the House Committee on Manufactures and Commerce at Columbus, Ohio, to advocate the passage of a bill introduced by Representative Reynolds, of Franklin County, to create a state board to examine and license electrical contractors. The proposed fee will probably be reduced from $100 to $50 for the first year's license.

Meetings of the Schenectady Section of the American Institute of Electrical Engineers.

An interesting lecture on the subject of "Gas Power" was delivered before the Schenectady (N. Y.) section of the American Institute of Electrical Engineers on February 6, by H. H. Supplee, editor of *Cassier's Magazine*. J. M. Knox, of the General Electric Company, and recording secretary of the local section, acted as presiding chairman, and the lecture was heard by a large and appreciative audience.

Mr. Supplee gave a comprehensive summary of the rapid development of the gas engine and gas turbine within the past ten years, also giving a brief historical review of the air engine, which has been in use in different forms for the past two centuries. The possibilities of the gas engine in the utilization of waste fuel in large iron works, in the form of gas from the top of blast furnaces and from coke ovens, which is commonly used in part for burning under the boilers, but the greater part of which is wasted, were clearly brought out. The question of the marketing of excess power generated from this fuel is of great importance, the saving of the waste fuel in the form of power bein of little advantage without the proper conditions for its commercial utilization. The necessity for the conservation of the world's supply of fuel, which has hitherto been used at a wasteful rate, makes this question of gas-engine development of special importance, as it is claimed that with the gas engine the utility of the coal is double that obtained with the steam engine. Furthermore, the fact that low-grade fuels, such as lignites, peats, bone coal and coals having a large amount of impurities, such as sulphur and ash, can be more successfully used with the gas engine gives it an additional factor of merit. Mr. Supplee said it was a mistake to compare the gas engine with the steam engine as if the gas engine were going to supersede it, but that there is room for both and both will play an important part.

An interesting series of lantern slides showing gas-engine installations, both in America and abroad, illustrated the tremendous advance which has been made in the development of gas power.

At a meeting held on February 13, C. J. Mellin, consulting engineer of the American Locomotive Company, gave a talk on the "Design of Steam Locomotives." There were about three hundred present, S. T. Dodd, acting chairman, opening the meeting with a few general remarks on the subject.

Mr. Mellin said in part that the first consideration in the design of a locomotive is the allowable wheel pressure on the rail, the weight at the driving wheels being determined by that. The number of driving wheels is generally limited to four pairs in freight and three pairs in passenger engines, the length of the rigid driving wheel-base being limited to sixteen or seventeen feet, on account of curves. A two-wheel pony truck is considered most suitable for freight engines, while a four-wheel truck is most generally used in passenger service, but for the varying conditions of service naturally several types of engine are necessary. The different types are distinguished from each other by names and figures, the figures generally representing the grouping of the wheels. The first figure signifies the number of wheels on first truck; second figure, number of drivers, and third figure, number of wheels in trailing truck. Thus we have the light passenger engine classified as 4-4-0; the medium size, or Atlantic type, 4-4-2; the heavy passenger, or Pacific type, 4-6-2, and the ten-wheel type, 4-6-0; the latter, as well as the Mogul type, 2-6-0, and the Prairie type, 2-6-2, being most suitable for mixed or fast-freight service. For regular freight service the Consolidation, 2-8-0, has practically become standard.

The required cylinder power is figured on the basis of tractive weight, or weight of driving wheels on the rail. The boiler pressure is always predetermined, and the diameter of drivers is about equal, in inches, to the speed the engine is expected to run, in miles per hour. The stroke is selected so as to give the required maximum train speed to a moderate piston speed.

Two of the most important factors in a successful locomotive are the heating surface and grate area. The method of determining these factors which has generally been adopted and gives satisfactory results is to make the heating surface in square feet not less than 450 times the volume of one of the cylinders in cubic feet, for passenger engines, and 400 for freight, the grate area being about one-seventieth of this amount.

Diagrams of construction, curves and photographs of locomotives were shown by means of lantern slides. Mr. Mellin also gave a detailed description of the Walschert valve, illustrated by diagrams.

On February 20 E. J. Berg, of the General Electric Company, delivered a lecture on "Rotary Converters."

Current Electrical News

LARGE POWER PLANT FOR CANAL WORK—The Isthmian Canal Commission has awarded a contract to the General Electric Company for furnishing a power plant to handle the material to be used in the construction of the Gatun locks at a price between $194,000 and $197,000, the exact figure to be fixed by the engineers on the isthmus.

OHIO RAILWAY FRANCHISE BILL PASSED—The Schmidt street railroad franchise bill has been passed by unanimous vote of the Ohio senate. The specific provision of the bill is that franchises may be granted to new companies over routes that have been occupied within a year by an old company, without obtaining new consents of the owners of abutting property. The bill is of special interest in Cleveland and Toledo where valuable franchise rights are about to expire.

SOUTHERN POWER COMPANY TO EXTEND SYSTEM—A movement is on foot to have the Southern Power Company, one of the largest electrical plants in North Carolina, enter Salisbury at an early date. The plan is to co-operate with the Salisbury-Spencer Railway Company in the distribution of light and power in the two towns. New and improved machinery is to be installed by the local electric company in the event the Southern Power Company extends its lines from Charlotte to Salisbury.

CHICAGO ELECTRIC ROADS MERGE—Plans for the consolidation of the Calumet Electric Street Railway Company and the South Chicago City Railway Company have been completed. The new company will be known as the South Chicago Railway Electric Company. H. M. Sloan will be general manager of the new road and W. Matson, general traffic manager of the South Chicago City Railway Company, will occupy the same position in the new company. The consolidation will be effected as soon as the ordinance now before the subcommittee of the local transportation committee shall have been passed. Among the improvements intended by the company is a through line from South Chicago to Hegewisch.

SOUTHERN PACIFIC TO BUILD ELECTRIC LINE—Plans for an electric railroad between San Francisco and San Jose, Cal., to be called the Peninsular Railroad, have been completed by the Southern Pacific. It is believed the road will be in operation early in the summer. The old Southern Pacific tracks through the Mission district to the cemeteries will be used. Between the cemeteries and San Mateo the company will have traffic rights over the lines of the United Railroads Company. This is thought to be another step in the plans outlined by the organization of the San Jose-Los Gatos Interurban Electric Railroad five years ago, when forty miles of track were laid. A year later Harriman formed the Peninsular company to connect the San Jose interurban railroad with San Francisco. The Peninsular company now is undertaking its construction work. It is building from San Jose north to Mayfield, and also is constructing several branch lines. One of these will be a scenic road from San Jose to the Lick observatory on Mount Hamilton.

EXTENSIVE WESTERN POWER DEVELOPMENT—Announcement is made in Spokane, Wash., that the Pacific Coast Power Company, recently organized by the Stone & Webster interests, with headquarters in Boston, will erect, at the foot of Lake Tapps, in Pierce County, Washington, west of Spokane, at a cost of $10,000,000, the second largest electric power plant in the United States, having ultimately a capacity of 100,000 horse-power. The plant will develop 50,000 horse-power at first and subsequently will be increased to its maximum capacity as fast as additional power is required for the network of interurban electric railways and for the standard gauge interurban system which will unite the cities of Bellingham, Everett, Seattle, Tacoma, Olympia, Aberdeen and Hoquaim and Portland, Ore. It is given out that work will begin in a short time, and that it will be pushed to completion. The water rights and properties involved in this power project, concerning which the Seattle-Tacoma Power Company and the Stone & Webster interests have been in disagreement, have been amalgamated and will be developed. Jacob Furth, president of the Seattle Electric Company, gave out the following statement: "The Pacific Coast Power Company has acquired all the White River lands, so-called, which have been the subject of so much recent litigation. This company will develop the property, but the detailed plans for its development have not yet been completed. The White River situation is one of the greatest power projects on the sound, and the present settlement of the disputes and litigations concerning it, thus insuring its early development, will be of the greatest benefit to the cities of Seattle and Tacoma. It is expected that more than $5,000,000 will be expended in the initial development. The maximum development is estimated to be 100,000 horse-power." In addition, the power from the White River project will be used in the development of manufacturing industries in the Puget Sound basin and in the southwestern part of Washington. The Pacific Coast Power Company will practically take the whole of White River from its bed at the foot of the glaciers on Mt. Rainier and lead it through ditches and flumes to Lake Tapps, a large body of water in Pierce County. Lake Tapps is on the shoulder of a mountain and there is a drop of more than 400 feet at an angle of forty-five degrees from the lower end of the lake. It is planned to impound the waters of White River in Lake Tapps, which will be greatly increased in size.

TELEPHONE AND TELEGRAPH.

CATASAUQUA, PA.—The Pennsylvania Telephone Company is installing a new exchange in the Post-Office Building, Catasauqua.

NASHVILLE, TENN.—The annual report of the Cumberland Telephone and Telegraph Company for the year ended December 31 shows gross earnings of $5,917,273 as compared with $5,384,844 for 1906. The total surplus is $2,768,783 as against $2,343,775 for the preceding year.

BROOKS, ME.—At the annual meeting of the Waldo & Penobscot Telephone Company, officers were elected as follows: Directors, A. E. Kilgore, F. R. York, M. S. Stiles, T. I. Huxford, R. E. Page; secretary and treasurer, A. R. Tilley. The lines will be further extended next spring.

BALTIMORE, MD.—At the annual meeting of the Maryland Telephone Company, recently acquired by the Bell interests, the following were elected directors: U. N. Bethell, of New York; F. H. Bethell, of Philadelphia; A. P. Cranshaw, of Washington; Bernard Carter, Charles H. Carter, J. Walter Lord and C. E. Bryan, of Baltimore

TREZEVANT, TENN.—At a meeting of the stockholders of the Trezevant Telephone Company, of this city, it was decided to incorporate the company. The capital stock was placed at $1,000, and 100 shares, of $10 each, will be issued at once. The secretary was instructed to apply for a charter and the new company will soon be incorporated. The building of the lines will begin at an early date, the poles now being placed, and the other building materials having been ordered. A 100-line switchboard has been purchased. The company hopes to be doing business within sixty days.

MILWAUKEE, WIS.—Three-quarters of a million dollars will be expended by the Wisconsin Telephone Company in 1908 for the improvement of its lines throughout the state, according to a decision reached by the board of directors at its annual meeting. A large portion of this sum will be spent in extending toll lines in the northern part of the state. The usual semi-annual dividend of three per cent was declared to stockholders. Those present at the meeting were: Alonzo Burt, president; C. J. French, Boston, Mass.; Otto H. Falk, Henry F. Whitcomb, O. C. Fuller, Julius O. Frank and Edward A. Uhrig.

ELECTRIC LIGHTING.

MONTESANO, WASH.—The Montesano Light and Water Company has installed a new turbine unit in its plant.

CORNING, ARK.—G. A. Booser has purchased the Corning electric light plant from E. V. Sheeks and will give that town an all-night service.

BASTROP, TEX.—The Bastrop water and light plant has been sold by the directors to Robert Bayne, of Fort Worth, subject to the ratification of the stockholders.

CARTERVILLE, ILL.—The electric light plant owned and operated by A. C. Hope & Sons was destroyed by fire on February 7, involving a loss of $30,000, with no insurance.

EAST MOLINE, ILL.—A twenty-five-year electric light and power franchise has been granted William Downing, of Silois, representing the United Light and Power Company.

ROCKLAND, ME.—The city council has renewed the lighting contract with the Rockland, Thomaston & Camden Street Railway for a period of one year. Sixty-two lights are furnished at $87.50 each.

BOULDER, COL.—Operations of the Central Colorado Power Company, of which the Eastern Colorado Power Company, operating in this county, is a subsidiary, have been resumed in various parts of the state and at Shoshone.

LECOMPTE, LA.—The town council has completed plans for the electric light plant and has advertised for bids for the construction of the plant which is to cost $10,000, according to the plans and specifications on file in the mayor's office.

MADISON, WIS.—The capitol building commission has let the contract for electrical equipment of the new capitol to the Northern Electrical Manufacturing Company, of Madison, at $42,000. This includes all electrical machines, fixtures and wiring.

FITCHBURG, MASS.—A flat rate of ten cents per kilowatt-hour has been made by the Fitchburg Gas and Electric Light Company to the city departments using incandescent lights. This will mean a saving to the city of between $400 and $500 a year.

EUGENE, ORE.—The Lane County Court has granted John Turrell, owner of a flour mill at Creswell, a twenty-year franchise to erect and maintain an electric light plant which will furnish light to the town of Creswell and the farmers in the surrounding country.

AMERICAN FORK, UTAH—At a meeting of the stockholders of Utah County Light and Power Company James O. Bullock was re-elected a director; George Romney, of Salt Lake, and Mayor James T. Gardner, of this place, were elected members of the board.

BALTIMORE, MD.—Henry J. Hemmens, Cortland Betts and Arthur H. Elliott have been elected to the board of directors of the United Electric Light and Power Company, succeeding Osborn W. Bright, H. E. Gawtry and William Bunker. The other directors were re-elected.

FRANKLIN, MASS.—The selectmen of Franklin have entered into a three-year contract with the Union Electric Light Company. Forty-three arc lamps and fifty-five thirty-two-candle-power incandescents are to be furnished. The lamps are to be operated on one of three schedules selected by the selectmen.

NORWICH, CT.—The floating of a $495,000 bond issue has been completed by the city of Norwich. Nearly half of the issue is for the bonds representing the purchase price of the gas and electric plant, the amount being $227,000. For improvements to the gas and electric plant there are bonds amounting to $60,000.

WILKES-BARRE, PA.—After having given the municipal ownership plan a thorough trial in the operation of its electric lighting plant the borough of McAdoo has decided to lease the plant to a private company. The company is comprised of John S. Wise, Jr., and Nicholas Keuck. They are known as the McAdoo Electric Company, of McAdoo.

REDDING, CAL.—The Shasta Power Company, which only recently turned on light and power in Redding, is preparing to extend its lines north and south. The Shasta company will build its lines north as far as Kennett and south at least as far as Red Bluff, serving Kennett, Coram, Keswick, Redding, Anderson, Cottonwood and Red Bluff.

MALONE, N. Y.—F. G. Shufelt, of Malone, has purchased of Ernest A. Douglas, the plant and franchises of the Chateaugay Electric Light and Power Company. This is the first plant which furnished electric light for Chateaugay. It is now devoted solely to private lighting, the Chasm Power Company having the contract for lighting the village streets.

SHARPSBURG, MD.—The burgess and commissioners of Sharpsburg have awarded a contract to John C. Livers to light the streets of the town with electricity, and the plant will be installed at once. The contract calls for fifty-five arc lights. Current for the lights and also for commercial purposes will be furnished from the plant at Shepherdstown, on the Potomac River.

NEWMARKET, N. H.—At the annual meeting of the stockholders of the Newmarket Electric Light, Power and Heat Company the following officers were elected: Clerk, Charles A. Morse. Directors: Fred B. Philbrick, Charles A. Morse, Arioch W. Griffiths, Leonard R. Philbrick, Sarah J. Woodman, Charles B. Edgerly, George E. Smith. The directors then elected these officers: President, Fred B. Philbrick; vice-president, Leonard R. Philbrick; treasurer, Sarah J. Woodman.

PLAINFIELD, N. J.—At a meeting of the Westfield town council J. W. Horton, representing the American Light, Heat and Power Company, submitted a petition requesting that body to grant a twenty-year franchise to the company, giving it the exclusive right to build a plant for the lighting and heating of the town at a cost not to exceed ten cents per kilowatt-hour. The petitioners agree to pay the town two per cent of the net earnings and to give free lighting to the public library, firehouses and town buildings.

OGDEN, UTAH—The plans for the erection of a large power plant at Devil's Gate, in Weber Cañon, have been completed, and officials of the Utah Light and Railway Company announce that work will be begun in the early spring. The plant will cost $350,000 and will be built by the Utah Light and Railway Company, which is a part of the Harriman system. Power lines will be run from the plant to Ogden and on to Salt Lake City, where the power will be used to operate the street-car system. Electric power will be furnished to the machine shops, roundhouses and other departments of the system in the city.

ELKHART, IND.—The Indiana & Michigan Electric Company, of this city and South Bend, has been granted a franchise by the city council of Niles, Mich., permitting the company to furnish electric power to all manufacturing and other establishments desiring it. Some time ago the company asked for a franchise of this character and the council refused to grant it. Recently, however, the council asked the company to again present its franchise and when this was done it was immediately granted. It covers a period of thirty years and does not permit the company to provide electric lighting except upon the consent of the council. This is to protect the municipal lighting plant.

DETROIT, MICH.—The estimates submitted by the public lighting commission include $239,443.76 for extensions and improvements of the municipal public lighting system, an increase of $155,751.52 over the amount allowed last year for this purpose. The total amount asked for by the commission is $401,342.01, an increase of $152,722.70 over what was allowed last year. Some of the most important improvements asked for are: One 2,000-kilowatt turbine unit, $64,000; 200 enclosed arc lights, $8,200; for installation of arc lights, $24,000; for fifty-six enclosed arc lights to replace present lights, $12,485; for substation feeder to increase the capacity of the Custer avenue substation, $4,977.84; for lines to supply current for lighting the addition to Central High School, $2,830.36; for purchase of land for a pole yard, $9,000; for underground extensions in Grand River avenue from Washington avenue to Commonwealth avenue, $36,861.98. The sum of $62,885.98 is asked for placing conduit wires in accordance with the new ordinance. The operation and maintenance of lights will cost $166,546.75, a decrease of about $9,000 from what was allowed last year, but $5,351.50 is asked for operation and maintenance in Fairview and Woodmere.

PERSONAL MENTION.

MR. HARRY S. HOLM has been appointed general agent of the Fort Dodge, Des Moines & Southern Interurban. Mr. Holm will have full charge of the traffic and operating affairs in Fort Dodge, Iowa.

MR. JULES E. DUPUY, for a number of years manager of the New Iberia (La.) municipal electric light plant and waterworks, resigned at a meeting of the board. The resignation takes effect April 1.

MR. JAMES L. SULLIVAN, of Worcester, Mass., has succeeded Richard T. Lawless as purchasing agent of the Berkshire Street Railway Company, and Daniel E. Burgess, of Westfield, George R. Scarritt as roadmaster of the company.

MR. ARTHUR L. SMITH, formerly superintendent of the Lexington (Ky.) Street Railway Company, who resigned shortly after the present manager, J. B. Crawford, took up the duties of his new office, has accepted a position with the Northern Traction Company, of Cincinnati, Ohio.

MR. HENRY H. DALTON, auditor of the Raleigh (N. C.) Electric Company, has resigned that position to accept a position with the accounting department of the Electric Bond and Share Company, of New York. He is succeeded by Mr. E. P. Summerson, of Decatur, Ala., formerly cashier of the Heat and Fuel Company, of that city.

MR. HENRY DOCKER JACKSON is taking a well-earned vacation in Bermuda, having finished an important piece of work for the city of Brockton, Mass. He has formed an association with Harvey Y. Currey, of Chicago, Ill., and is making plans for an association on the Pacific coast as well. Hereafter he will extend his field to include Mexico and Canada, as well as the United States.

PROFESSOR C. F. HARDING has been appointed head of the School of Electrical Engineering of Purdue University. Professor Harding is a graduate of Worcester Polytechnic Institute, and has had a broad practical training as an engineering teacher. His special training has been along the line of high-tension railway work, and he was electrical engineer for the first railway of that character in New England. He has been engineer for the D & W Fuse Company, of Providence, R. I., publication manager for the Fort Wayne Electric Works, and engineering expert for Stone & Webster, of Boston. He was also associate professor of electrical engineering at Cornell University. Professor Harding will assume his duties about the first of March.

MR. PETER COOPER HEWITT was one of the bidders for the construction of dirigible balloons for the United States Army when bids were opened in Washington, D. C., on Saturday, February 15. Mr. Hewitt has recently announced that he was experimenting on a dirigible machine which would make sixty miles an hour. He offered in his bid to furnish the dirigible balloon in 200 days at a cost of $20,000. The specifications covering the construction of the dirigible balloon called for a gas bag supporting a suitable framework on which is to be mounted the necessary propelling machinery. The balloon is to carry a combined weight of 350 pounds, and at least 100 pounds of ballast. It must have a speed of twenty miles an hour in still air, and the builders were required to submit proposals for cost depending upon the speed attained during the trial flight.

MR. WYNN MEREDITH has been admitted as a member of the firm of Sanderson & Porter, and will take charge of this company's western office, with headquarters in the Union Trust Building, San Francisco, Cal. After a technical training at the University of Illinois, Mr. Meredith, in 1888, became engaged in the construction and operation of lighting and railway properties. He was actively connected with the engineering and operation of the electrical plant of the World's Fair at Chicago, in 1893, and the California Fair in 1894, subsequently becoming associated with Messrs. Hasson & Hunt, and later a member of the firm of Hunt, Dillman, Meredith & Allen, San Francisco, Cal. During fifteen years' residence in California Mr. Meredith has been engaged in general engineering work and prominently identified with many of the important hydroelectric and transmission developments on the Pacific Coast, in the United States and Canada.

MR. ROBERT T. LOZIER, New York manager of Dodge & Day, Philadelphia, Pa., has worked up a very interesting data sheet bearing on the present financial and industrial situation. According to observations which Mr. Lozier has made, and which are borne out by statistics and Government reports, sharp declines are indicated, with quick recoveries in material and money markets corresponding to the stock market. If these occur as expected it will be a long time before such favorable conditions for building will again be found. The curves indicated show that the materials and money market follow very closely the decline in the price of stocks, and that the present time is one in which the investor and promoter should prepare his specifications, so that during the spring months materials may be purchased. The indications are that by summer time money will be easier to secure, and the rates of interest lower than at the present period or during the fall, and that the payment for material and construction can be made then at the most advantageous terms.

OBITUARY NOTES.

MR. JOHN F. RANDOLPH, treasurer of the various Edison companies, and secretary to Thomas A. Edison, died suddenly at Orange, N. J., on February 17. Worry over business cares is given by his associates as the reason for his suicide. Mr. Randolph had been associated with Mr. Edison since his boyhood, entering his employ at fifteen years of age.

MR. WALTER I. BARNES, assistant general manager of the Narragansett Electric Lighting Company, died on February 7 after a lingering illness, covering a period of two years, at his home at Manton, near Providence, R. I. Mr. Barnes had held the position of assistant general manager for some years. He entered the employ of the company in October, 1891, as a salesman, working up to the position of general superintendent in July, 1895. He held this position for a number of years. About two years ago he was elected to the office of assistant general manager. Mr. Barnes was born in Cranston, R. I., December 20, 1859. He was educated in the public schools in Johnston, the Mount Pleasant Academy, and was a graduate of the commercial school of Bryant & Stratton. He never married, and lived practically all his life in Johnston with his mother and two sisters, who survive him.

NEW MANUFACTURING COMPANIES.

OLEAN, N. Y.—The National Railroad Trolley Guard Company has been incorporated with a capital of $5,000. The directors are: W. K. Page, O. W. Pierce, Olean; L. J. Mayer, New York.

BROOKLYN, N. Y.—The Marco Storage Battery Company has been incorporated with a capital of $5,000 and the following directors: P. M. Marco, Herman Mallfeld, Brooklyn; Charles Standt, West Hoboken, N. J.

ALBANY, N. Y.—The Federal Signal Company, of Albany, with a capital stock of $2,000,000, of which $600,000 is to be eight per cent cumulative preferred and $1,400,000 common stock, has filed a certificate of incorporation with the secretary of state. The company is to manufacture signals, switches, interlocking and safety appliances for railways of all descriptions. The directors are: Alfred H. Renshaw, of Noroton, Ct.; Eugene Seitz, of Gold Hill, Ore.; Frederic Pruyn, of Loudonville, Albany County; Augustus Veghte, of Albany, and James H. Caldwell, of Troy.

ENGINEERING SOCIETY NOTE.

SOCIETY OF CHEMICAL INDUSTRY—The programme for the meeting of the New York section of the Society of Chemical Industry, which was held at the Chemists' Club, 108 West Fifty-fifth street, New York city, on Friday, February 21, contained, among other papers, one by Roland Carlberla on "Manufacture of Ferro-Chrome in the Electric Furnace." E. A. Sperry had a paper on "The Preservation and Uses of Anhydrous Tetrachloride of Lime"; Maximilian Toch one discussing "The Influence of Sunlight on Paints and Varnishes," and Charles Baskerville one discussing "The Injury to Vegetation by the Fumes from Chemical Factories."

DATES AHEAD.

Ohio Independent Telephone Association. Annual meeting, Columbus, Ohio, March 19.

Iowa Electrical Association. Annual meeting, Des Moines, Iowa, April 22-23.

Iowa Street and Interurban Railway Association. Annual meeting, Des Moines, Iowa, April 24.

National Electric Light Association. Annual meeting, Chicago, Ill., May 19-22.

ELECTRICAL SECURITIES.

For several weeks there has been a general lagging tendency in speculative activity, and the market has indicated a condition of temerity and apathy, which suggested that there was an overshadowing anxiety which would preclude the possibility of a rise in prices for some time to come. At the beginning of last week there was a violent break in values which brought about almost as serious declines as were witnessed during last year's panic period. This appears to have been caused by the buying power in the market reaching a natural culmination in the latter part of January. In the rebound from the severe decline the speculators who bought stocks on top of the January boom found little chance to dispose of them to advantage, and they finally began to hurriedly throw over their purchases. The feeling of pessimism that this brought about naturally resulted in the decline just mentioned. The over-subscription of the New York city $50,000,000 bond issue shows that there is a great volume of money ready to be placed upon safe investments, and this is a very gratifying indication. It is likely that the Aldrich currency bill, in some modified form, will be passed by the national legislature, although there is at present a great deal of opposition to it.

Dividends have been declared upon the following electrical securities: American Railways Company, Philadelphia, Pa.; regular quarterly dividend of 1½ per cent (seventy-five cents per share), payable March 16. Books close February 29 and reopen March 4. Rochester (N. Y.) Railway and Light Company; regular quarterly dividend of 1¼ per cent on the preferred stock, payable March 2, as registered February 25. Kansas City (Mo.) Railway and Light Company; regular quarterly dividend of 1¼ per cent on the preferred stock, payable March 2. Scranton (Pa.) Railway Company; semi-annual dividend of 2½ per cent on preferred stock 5 per cent gold trust certificates, payable March 1.

ELECTRICAL SECURITIES FOR THE WEEK ENDED FEBRUARY 15.

New York:	*Closing.*
Allis-Chalmers common	6
Allis-Chalmers preferred	17
Brooklyn Rapid Transit	38⅞
Consolidated Gas	97
General Electric	114
Interborough-Metropolitan common	7⅝
Interborough-Metropolitan preferred	19⅛
Kings County Electric	92
Mackay Companies (Postal Telegraph and Cables) common	53¼
Mackay Companies (Postal Telegraph and Cables) preferred	61½
Manhattan Elevated	124
Metropolitan Street Railway	15
New York & New Jersey Telephone	98
Western Union	46½
Westinghouse Manufacturing Company	40

Boston:	*Closing.*
American Telephone and Telegraph	105¾
Edison Electric Illuminating	200
Massachusetts Electric	—
New England Telephone	108
Western Telephone and Telegraph preferred	55

The American Telephone and Telegraph Company issues the following statement of earnings for the fiscal year ended December 31, 1907: Dividends, $11,805,166; interest and other revenues from associated and licensee companies, $9,307,023; telephone traffic (net), $3,901,653; real estate, etc., $595,826; total, $25,609,671; expenses, $2,130,381; net earnings, $23,479,290; interest, $7,209,902; balance, $16,269,387; dividends, $10,943,644; surplus, $5,325,743. This compares with $2,775,703 for the preceding year. The above balance of $16,269,387 for dividends is equal to 10.61 per cent on the $153,476,600 capital stock outstanding at the close of the year, against 9.86 per cent on the $131,551,400 stock outstanding as of December 31, 1906.

At the annual meeting of the Mackay Companies 241,626 shares of preferred and 189,998 shares of common stock were voted in favor of the re-election of the present board of seven trustees.

Philadelphia:	*Closing.*
Electric Company of America	8⅝
Electric Storage Battery common	26
Electric Storage Battery preferred	26
Philadelphia Electric	5⅝
Philadelphia Rapid Transit	15
United Gas Improvement	76

At the annual meeting of the Electric Storage Battery Company, next month, stockholders will be asked to approve a proposal to reduce the par value of the stock from $100 to $50, and thereby reduce the capital from $18,000,000 to $9,000,000. There is only one class of stock outstanding.

Within the next month a special meeting of the directors of the United Gas Improvement Company will be held to consider a plan to further finance the needs of the company by an issue of additional stock. A dispatch from Philadelphia says that there is reason to believe that an allotment of twenty per cent, or $9,176,970, will be made pro rata to stockholders at par.

Chicago:	*Closing.*
Chicago Telephone	115
Commonwealth Edison	87
Metropolitan Elevated preferred	45
National Carbon common	55
National Carbon preferred	103

NEW PUBLICATIONS.

LIGHTHOUSE BOARD.—The annual report of the Lighthouse Board to the Secretary of Commerce and Labor, Washington, D. C., for the year ended June 30, 1907, has been issued. This contains the usual reports relating to the various lighthouse districts, showing what changes, if any, have been made.

"THE WORK OF THE ELECTRICAL TESTING LABORATORIES"—This is a reprint of a very interesting paper read by Wilson S. Howell, of the Electrical Testing Laboratories, Eightieth street and East End avenue, New York city, at the twenty-third annual meeting of the Association of Edison Illuminating Companies, held at Hot Springs, Va., September 10-12, 1907. The paper shows that the work of the Electrical Testing Laboratories has grown very popular, and the laboratories have among their clients a large number of manufacturers and private investigators. Even those manufacturers who have large laboratories of their own call upon the Electrical Testing Laboratories to do special work and to undertake exhaustive research and investigation. A table in this paper indicates that, as compared with the published reports of the Reichsanstalt, of Germany, and the Laboratoire Central, of France, that the Electrical Testing Laboratories stand substantially on a par with these national laboratories of France and Germany. In respect to the ordinary tests, along which this laboratory has had a longer growth, its supremacy is incontestable.

STATISTICAL TABLES—Spencer Trask & Company, bankers, William and Pine streets, New York city, have issued the 1908 edition of "Statistical Tables," comprising eighty-four pages replete with information relating to American railroad and industrial companies. There are also details covering practically all of the securities dealt in upon the New York Stock Exchange, and the booklet includes a fund of information not otherwise readily obtainable by the individual investor. The statistics devoted to railroad bonds show the amount outstanding, the rate of interest, the interest dates, the number of miles upon which the bonds are a lien, high and low and last price in 1907, and the approximate yield. Information of the same general character is given upon the bonds of street railway, gas, electric light and industrial companies, and Government bonds. The statistics devoted to railroads give the average mileage operated, capitalization, dividends and dates of payments, gross and net earnings, fixed charges, and range of stocks for 1907. The same records are given as applied to street railway, electric light and industrial companies. In addition several pages are devoted to explaining just what stocks are cumulative or non-cumulative as to dividends, and also the amount of dividends to which preferred stocks are entitled, and whether or not they are also preferred as to assets.

EDUCATIONAL NOTE.

THE JOHNS HOPKINS UNIVERSITY will hold, on February 22, the annual commemorative exercises of the opening of the university. The exercises will take place in McCoy Hall, and the address will be delivered by the Hon. Lebbeus R. Wilfley, Judge of the United States Court for China, the subject being "America's Opportunity in China." The exercises will begin promptly at eleven A. M.

ELECTRIC RAILWAYS.

SHREWSBURY, PA.—Residents of Shrewsbury and vicinity intend to build a trolley line from Shrewsbury to York, passing through Glen Rock, Loganville, Paradise and Violet Hill.

MANSFIELD, MASS.—The proposed Providence & Boston Interurban Electric Railroad has applied to the Mansfield selectmen for a franchise. A hearing will be given the company some time in March.

ST. PAUL, MINN.—Plans have been filed by the Twin City Rapid Transit Company for an addition to its hydroelectric plant on Nicolet avenue which will give it an ultimate increase in capacity of 12,000 horse-power.

LOS ANGELES, CAL.—Wells Fargo & Company has taken over the entire express business of the Los Angeles Pacific Railroad, Harriman's electric system, which serves Santa Monica, Ocean Park, Redondo and a score of other small cities. The new arrangement went into effect February 1.

GUTHRIE, OKLA.—It is understood that plans are being formulated for the building of an interurban railway from Pauls Valley to Anadarko, and that an electric line will be installed in the city of Chickasha. Scott Jones is the promoter of the scheme. He is said to have the backing of New York capital.

ALBIA, IOWA—The opening of the Albia Interurban Railway was celebrated at a banquet given by the Albia Business Men's Association on January 31. This banquet was given in honor of the builders and officers of the railway. The guests of honor were Calvin Manning, C. B. Judd and C. A. Ross.

MOGOLLON, N. M.—The Ernestine Mining Company, through its president, E. Craig, has made a proposition to the government to buy 50,000 cords of wood on the Gila national forest. An electric road eight miles long would be built into the heart of one of the best-timbered portions of the Gila.

SAN FRANCISCO, CAL.—The statement is made upon the authority of Guy C. Earle, vice-president of the Great Western Power Company, of Big Bend, on the Feather River, that the Western Pacific Railroad, now being built from the East to this city, will use electricity for motive power.

NORTH YAKIMA, WASH.—Work on the organization of a company to build an electric line between North Yakima and Granger has been placed in the hands of a committee consisting of W. N. Granger, H. H. Lombard, J. H. Thomas, A. P. Wilcox, F. G. Page, George P. Eaton and C. H. Putnam. The road will run by way of Yakima City, Parker and Zillah.

MILWAUKEE, WIS.—Officials of the Chicago & Milwaukee Electric Railway have announced that with the opening of the new line to Milwaukee on June 1, the company will place parlor cars and dining cars in service on the run between Milwaukee and Chicago. These cars are now being built and it is claimed that they will be similar to the cars now used on steam railways.

SEATTLE, WASH.—An electric trolley line, electric lights and a steam-heating plant are to be established on Vashon Island if a petition filed with the board of county commissioners is granted. F. X. Waldron & Company ask for the franchise, and their request is backed by the approval of 260 citizens and taxpayers of the island. The proposed road is to be eight miles long.

WEST CHESTER, PA.—At the annual meeting of the stockholders of the West Chester Street Railway Company the following officers received the unanimous vote cast: President, Meyer Schamberg, of Philadelphia; directors—Meyer Schamberg, George D. Woodside, John A. Brill, John F. Bruce, Jonas Rice, all of Philadelphia; Robert T. Cornwell and Marshall H. Matlack, of West Chester.

MACON, GA.—President W. Jordan Massee, of the Macon Railway and Light Company, has made a contract for new power-house equipment. The new machinery will cost $53,000 and will be installed this spring. It consists of a new turbo-generator that will develop 2,500 horse-power and will be able to carry a fifty-per-cent overload for four hours in case of an accident to the other machinery.

SAN FRANCISCO, CAL.—At a meeting of the stockholders and directors of the Parkside Transit Company the following officers were re-elected: President, J. E. Green; vice-president, J. W. O'Brien; secretary, G. A. Nicholls. Directors: William Crocker, John J. Mahoney, C. E. Green, Hugh Keenan, William Matson, Wellington Gregg, Jr., John Daniel, W. B. Cope, A. F. Morrison, G. A. Nichols, J. M. O'Brien and J. E. Green.

AUGUSTA, GA.—A franchise has been granted by the city of Augusta to the Atlanta & Carolina Construction Company for the use of the streets of Augusta, the company to have a double-track trolley line completed within two years from date; the work to be started within a year. The company will construct a trolley line from Atlanta to Augusta *via* Athens. Announcement is made by officials of the company that they will commence construction work at once.

BELLEVILLE, ILL.—Articles of incorporation of the Red Bud & Belleville Interurban Railway Company have been filed at Belleville. The company proposes to construct an electric railway from Red Bud, through Randolph, Monroe and St. Clair counties, to Smithton, seven miles south of Belleville, where it is to connect with the Belleville Interurban. The incorporators and first board of directors are: C. C. Smith, Conrad Becker and Herman Shryver, of Red Bud; John Keller, of Hecker, and Ben A. Gundlach, of Belleville.

MUSKOGEE, OKLA.—The Missouri, Oklahoma & Gulf Railroad, which is operating a line between Wagoner and Dustin, a distance of nearly 100 miles, is the first railroad in Oklahoma to make a serious attempt to electrify its line. The company has been conducting experiments along this line for a year, with satisfactory results. It is proposed to make the section of road between Muskogee and Wagoner, a distance of fifteen miles, the experimental line to ascertain the practical economic value of running trains by electricity.

EAST LIVERPOOL, OHIO—After spending $2,000,000 and working twenty months, the East Liverpool Traction and Light Company has opened thirty miles of through traffic on its interurban road from the Ohio-Pennsylvania state line and the Ohio River, down the Ohio Valley to Steubenville, Ohio. Rapid construction is progressing on an eastern extension which will be opened March 1 and will extend east to Conway, Pa., or half way between Pittsburg and Rochester, Pa. With the opening of this line it is possible to travel down the Ohio Valley from the Ohio-Pennsylvania state line to Moundsville, W. Va., nearly eighty miles. Van Horn Ely and J. C. Rothery, of Buffalo, N. Y., are at the head of this syndicate, which is fast obtaining control of the traction and light franchises through the Ohio Valley.

EXCELSIOR SPRINGS, MO.—The officers of the Missouri Traction Company, which is promoting the electric line between Excelsior Springs, Mirabile and St. Joseph, have issued their second leaflet, giving a summary of the preliminary work thus far accomplished. The report of the engineer on the preliminary survey shows a route through Saxton, Garrettsburg, Malden Creek, Starfield, Delaney's, Horse Fork, Wolf's Branch, Lathrop, Converse, Sexton, Lawson and Old Claysville to Excelsior Springs and from Lathrop to Mirabile, through Bay School House. The mileage from St. Joseph here is fifty-four, and from Lathrop to Mirabile eleven, making a total of sixty-five. A conservative estimate places the cost per mile at $22,500, or a total of $1,462,500. The maximum grade of the route laid out in the preliminary survey is two per cent and this could be reduced by additional grading. The curvature does not exceed six degrees.

SEATTLE, WASH.—Work on the extension of the Pacific Traction Company's electric railway line from American Lake to Olympia will be begun in the spring. It is the purpose of the company to finish the eighteen or twenty miles of line during the summer and to have cars running between Tacoma and Olympia in the fall. With the filing of the certificate of appointment of E. J. Felt as state agent for the Pacific Traction Company, of Maine, came the announcement that the company would carry on its principal business in King, Pierce and Thurston counties. J. R. Thompson is the local financial agent of the company. That any extension of the company's lines into King County is contemplated this year is denied by the representatives of the company. It is the purpose of the traction company to build extensively as soon as times are better, but for this year the improvements will be confined to connecting Tacoma with Olympia by way of the American Lake line.

INDUSTRIAL ITEMS.

HARVEY HUBBELL, INCORPORATED, Bridgeport, Ct., is distributing some very attractive literature devoted to the Hubbell wire lamp guard and the Hubbell pull socket.

THE BURNLEY BATTERY AND MANUFACTURING COMPANY, North East, Pa., is distributing some attractive literature which will be furnished to those interested upon request. This is devoted to the Burnley soldering fluxes, soldering paste, soldering stick and soldering salts.

THE F. D. LAWRENCE ELECTRIC COMPANY, Cincinnati, Ohio, was subjected, on February 11, to considerable damage through fire in the rear of the building which it occupies. Provisions were made immediately to meet the demands for all kinds of supplies, and the company is experiencing no difficulty in keeping up with its orders.

THE HOLTZER-CABOT ELECTRIC COMPANY, Boston, Mass., has ready for distribution the following bulletins: No. 304B, devoted to single-phase, alternating-current motors; No. 302A, special type "M" motor-generators; No. 313, type "SS" motors; No. 314, type "C" motors and dynamos; No. 150A, new pattern "O" annunciators.

THE H. B. CAMP COMPANY, New York city, in the latest picture of its beautiful series of allegorical illustrations, shows a scene depicting a study in light and power, past and present. This shows a visionary picture of Abraham Lincoln studying by candle-light and an up-to-date picture of a modern business man at his roll-top desk, which is equipped with a modern electric light and desk reflector.

DOSSERT & COMPANY, New York city, manufacturer of the Dossert solderless connector, in its annual report for 1907 shows an increase in gross business of twenty-seven and one-half per cent, notwithstanding a falling off in the last quarter owing to slowing down of construction work. There has been a marked increase of orders since the first of the year, and the figures of January show a large increase over the same month last year.

THE SOUTHWESTERN MACHINERY AND SUPPLY COMPANY, Los Angeles, Cal., has been organized recently for the purpose of representing manufacturers of machinery and supplies exclusively in the fast-growing Southwest. This company is under the management of Charles L. Michod, who has been in the same business at St. Louis, Mo., and at Havana, Cuba, for the past five years. The president of the company is J. Wallace, of 42 Broadway, New York city. The vice-president and treasurer is Theodore G. Finley, of Los Angeles.

THE AUTOCOIL COMPANY, Jersey City, N. J., is calling attention to the issue to the company on February 4, 1908, of United States letters-patent No. 878,435, covering the invention of Richard Varley, of the multiple-unit system of induction coils. The application for this patent for a long time has been in interference in the patent office with an application of Ernest C. Wilcox, of the Connecticut Telephone and Electric Company, the matter at issue having been the well-known type of interchangeable induction-coil units, permitting of the removal and replacing of any unit without disturbing the electrical connections of the other units; as well as other features relating to the single and multiple battery switch, by means of which either one or two sets of batteries can be thrown into and out of use. This interference has finally terminated in the issue of the above-mentioned patent, and the company announces that any infringement thereof will be promptly and vigorously prosecuted.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., is distributing a timely and very interesting bulletin entitled "A Phase of the Panic." This takes up the present industrial condition from the central station point of view. The argument presented is directed to those central station managers who have decided to make limited line extensions for the present and give their new-business departments instructions to intensify where feeders are now located. The suggestion is made that the single-phase motor is the best "hard-times" friend that the central station man has. The central station man furnishes only the line connection and the transformer, and the bulletin states that money is being needlessly invested if the central station manager runs three wires and uses two transformers to supply a motor customer which he could handle with two wires and one transformer. Curves are given showing the characteristics for polyphase motors with squirrel-cage rotor, employing an auto-starter, and the Wagner single-phase motor with ordinary starting rheostat. The bulletin states that the Wagner single-phase motor takes less current from one phase of a polyphase circuit in starting than a polyphase motor from each of the three phases.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has issued a new series of advertising literature devoted to the following apparatus: Bulletin No. 4,563, General Electric switch indicator, type SI-104. This indicator is neat in design, weather-proof, insect-proof, strong, and every possible precaution has been taken to insure reliable operation. Bulletin No. 4,564 describes centrifugal air-compressors for industrial air-blast and exhauster service. These include low-pressure air-compressors rated from 0.88 pound to four pounds per square inch, and for capacities of from 750 to 10,000 cubic feet of free air per minute. These machines are similar to the well-known centrifugal pump both in appearance and operation, and consist essentially of a rotating impeller surrounded by a suitable casing with an intake opening at the centre and a discharge opening at the circumference. Bulletin 4,544 describes continuous-current railway switchboards. These represent the result of continuous improvements in previous designs, and among the improved features claimed for them are simplicity of arrangement, simplicity of installation, reliability and safety in operation and long life. Although each panel is an independent unit and may be ordered separately, the panels are especially designed to be used together to form switchboards. The bulletin covers several classes of panels, all of which are for 600-volt, continuous-current railway service, with the negative bus grounded. Bulletin 4,558 is devoted to isolated-plant switchboard panels with circuit-breakers. The demand for switchboards in isolated plants using a circuit-breaker in place of a combined lever switch and fuse has brought about the standardization by the company of a line of panels for small plant work of this character. The well-known type C, forms G and P, circuit-breakers, and the Thomson feeder-type measuring instruments are used on these panels.

Record of Electrical Patents.

Week of February 11.

878,493. TOOL FOR ELECTRIC WIRES. Harold B. Barnes, Leadville, Col. A combination pliers and clipper.

878,496. SYSTEM FOR CONTROLLING THE MOTION OF ELECTRICALLY OPERATED ELEVATORS BY MEANS OF A SWITCH. William Baxter, Jr., Jersey City, N. J. A group of coils spaced so as to cause a step by step movement of a rotating armature, whereby the controller contacts are manipulated.

878,498. SWINGING ELECTRIC BRACKET. John F. Brown, Toledo, Ohio. Slip rings and brushes complete the circuit through the swinging joint.

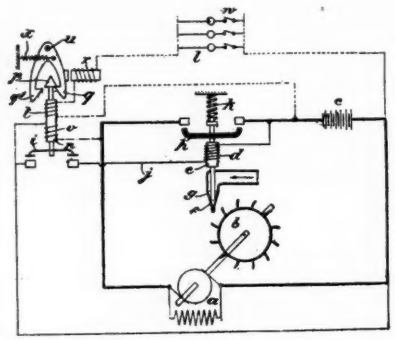
878,520. MEANS FOR TYING WIRES TO INSULATORS, ETC. Lewis W. Gerdon, Meadville, Pa., assignor of one-half to Edwin P. Barnes, Cleveland, Ohio. Two ties, each encircling the insulator, are employed.

878,525. ELECTRIC INSTALLATION WORKING WITH TURBO-DYNAMOS AND ACCUMULATORS. Max Grob, Winterthur, Switzerland. The admission valve is controlled by the current exchanged between dynamo and storage battery.

878,588. INSULATED RAIL JOINT. Benjamin Wolhaupter, New York, N. Y., assignor to the Rail Joint Company, New York, N. Y. The parts of the joint are assembled with a plastic insulating material interposed between them.

878,629. ELECTRIC MERCURY-MOTOR METER. Jacob H. Hodde, Springfield, Ill., assignor to Sangamo Electric Company, Springfield, Ill. A non-amalgamating washer is placed upon the submerged disc.

878,633. KEY SOCKET. Harvey Hubbell, Bridgeport, Ct. The circuit is opened or closed by a quarter turn of the key.



878,525.—ELECTRIC INSTALLATION WORKING WITH TURBO-DYNAMOS AND ACCUMULATORS.

878,646. HIGH-POTENTIAL INSULATOR. Fred M. Locke, Victor, N. Y. A wall insulator built up of concentric sleeves.

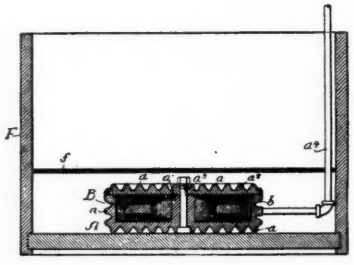
878,661. SYSTEM OF ELECTRICAL DISTRIBUTION. Robert S. McLeod, Manchester, England. A system employing a storage battery and booster.

878,679. SUPPORT FOR INSULATORS. William N. Smith, Yonkers, N. Y. The pin has a broad base by which it is strapped to the cross-arm.

878,756. CONTROLLER. Walter J. Warder, Jr., Chicago, Ill., assignor to Roth Bros., Chicago, Ill. A motor starter which may be controlled mechanically from a distance.

878,779. PARTY-LINE TELEPHONE SYSTEM. William W. Dean, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. A harmonic call system.

878,791. SUPERVISORY APPARATUS. Konrad Friedlaender, Berlin, Germany. A closed-circuit alarm system which operates by cutting out a series resistance when an alarm is given.



878,919.—ELECTRIC HEATER.

878,797. TELPHER. Henry M. Harding, New York, N. Y., and Charles M. Clark, South Orange, N. J. An electrically operated system, the trolleys being controlled by stops on the track.

878,836. SECURING DEVICE FOR TROLLEYS. Eberle D. Trickey, Blanchester, Ohio. A form of harp.

878,870. INSULATOR SUPPORT. Thomas J. Creaghead, Covington, Ky. A ribbed insulator pin with a soft metal seat for the insulator.

878,894. SIGNAL SYSTEM FOR ELECTRIC RAILWAYS. Charles F. Pike, Philadelphia, Pa., assignor, by direct and mesne assignments, to Charles F. Van Horn, Philadelphia, Pa. A block-signal system operated by the cars.

878,919. ELECTRIC HEATER. William R. Whitehorne, Brooklyn, N. Y., assignor to Edward F. Clements and M. Brook Jacobs, trustees, Philadelphia, Pa. The heating current is induced in the metallic casing surrounding the exciting coil.

878,923. SINGLE-PHASE MOTOR. James J. Wood, Fort Wayne, Ind. A motor with commutator and collecting rings and a stator winding short-circuited on itself.

878,949. ELECTRIC WIRE INSULATOR. John H. Hanson, Chicago, Ill. A cross-over insulator for wiring.

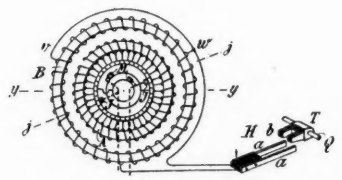
878,952. ELECTRICALLY HEATED SOLDERING AND BRANDING IRON. Harry Hertzberg and Maurice J. Wohl, New York, N. Y., assignors to Abbot Augustus Low, Horseshoe, N. Y. The heating resistance is enclosed within the metal head.

878,961. CONTROLLER FOR ELECTRIC MOTORS. Pearl N. Jones, Pittsburg, Pa. A pair of controllers which may be operated simultaneously or individually by means of a removable gear.

878,963. TELEGRAPHY. Isidor Kitsee, Philadelphia, Pa., assignor of one-half to William J. Latta, Philadelphia, Pa. A system of wire telegraphy.

879,033. INSULATOR FOR ELECTRIC WIRES. John Caldwell, Philadelphia, Pa. A cylindrical insulator with three grooves forming an equilateral triangle.

879,034. TROLLEY-POLE CONTROLLER. John J. Coit, Venice, Cal. A pneumatic trolley controller.



878,923.—SINGLE-PHASE MOTOR.

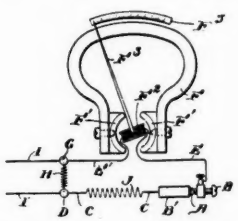
879,035. CABLE-TERMINAL. Frank B. Cook, Chicago, Ill. A distributing cable terminal provided with rings and fuses.

879,046. ELECTRICALLY HEATED SAD-IRON. Harry Hertzberg and Maurice J. Wohl, New York, N. Y. The heater is adjusted, by means of wedges, into close contact with the bottom of the iron.

879,061. RECTIFIER FOR ALTERNATING CURRENTS. George W. Pierce, Cambridge, Mass., assignor to Massachusetts Wireless Equipment Company, Boston, Mass. Carborundum is used as a unilateral conductor.

879,062. RECTIFIER AND DETECTOR. George W. Pierce, Cambridge, Mass., assignor to Massachusetts Wireless Equipment Company, Boston, Mass. A rectifier consisting of conductive oxid of titanium.

879,068. INSULATOR FOR HIGH-TENSION CURRENTS. Louis Steinberger, New York, N. Y. The conductor is threaded through a tubular portion of the insulator.



879,061.—RECTIFIER FOR ALTERNATING CURRENTS.

879,073. TELEPHONE AND STATION APPARATUS. Nuchim L. Weingott, Warsaw, Russia. A telephone instrument controlled by a key.

879,083. ELECTRIC INCANDESCENT-LAMP LUMINANT AND THE PROCESS OF MANUFACTURING IT. Francis M. F. Cazin, Hoboken, N. J. The filament is formed by plating a metal alloy electrolytically upon a core.

879,084. MANUFACTURE OF FILAMENTS IN ELECTRIC INCANDESCENT LAMPS, PROCESS AND PRODUCT. Francis M. F. Cazin, Hoboken, N. J. A carbon fillet covered with electrolytic deposits of different metals.

879,085. FILAMENT IN ELECTRIC INCANDESCENT LAMPS AND ITS MANUFACTURE. Francis M. F. Cazin, Hoboken, N. J. A carbon core electrolytically metallized.

879,117. RECTIFIER AND DETECTOR. George W. Pierce, Cambridge, Mass., assignor to Massachusetts Wireless Equipment Company, Boston, Mass. A rectifier consisting of a compound of silver and tellurium.